Progress Report for Investigations on New River

FY 1989 - FY 1990

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ABSTRACT

The U.S. Fish and Wildlife Service (Service) is currently funded by the Trinity River Restoration Program for the investigation of New River beginning in 1988 to the present. Continued decline of anadromous fish stocks in the Trinity River and its major tributaries has aroused concern in the basin and promoted a need to assess the current status of the salmonid stocks in the New River drainage and their potential for restoration to historical levels. Initial surveys of New River determined that the spring chinook run was dangerously low and the presence of the fall run chinook was unconfirmed. Summer steelhead surveys determined that New River supports one of the largest runs in California with counts exceeding 600 adults in 1989. Spring chinook redd counts ranged from 16 in 1988 to 11 in 1990. Spawning gravel habitat assessments for chinook determined that up to 2350 chinook pairs could be supported in the mainstem New River. Downstream migrant trapping operations were used to determine the emigration period for the juvenile salmon (May - June) and steelhead (March - May) to aid in management strategies for the protection of the smolts in the lower mainstem Trinity and Klamath Rivers. The "B" channel types dominate the mainstem New River although a high gradient "A" channel type is located in the lower 3 kilometers. Predominant habitat types by length for the mainstem were mid channel pools, low gradient riffles, lateral scour bedrock pools, and boulder scour pools. Temperature and discharge has been continuously monitored throughout the investigation where flows ranged from 24 to 10,000 cfs and mean daily temperatures ranged from 1.6 to 23 °C (35 to 74°F).

INTRODUCTION

The Trinity River Basin has experienced substantial declines in anadromous fish runs in recent years. Natural causes such as droughts and floods, as well as development associated with population growth, have contributed to a reduction in the fishery resource. The Trinity River Basin Fish and Wildlife Management Plan (TRBFWMP) has begun to address this problem by creating management options which would restore salmonid habitat availability and populations to historic levels in the Trinity River proper and significant tributaries.

New River is a pristine watershed and is virtually untouched by logging. It has shown a substantial recovery from the high water event during December 1964, when heavy sediment loads leveled streambeds. Since habitat for juvenile and adult salmonids does not appear to be fully utilized and is not heavily degraded, high potential for the use of New River as an index or key tributary to monitor changes in salmonid populations that are not associated directly with instream habitat improvement projects or watershed rehabilitation programs.

New River, a major tributary to the Trinity River, is currently being investigated. Most of the year, this water system runs clear which makes year round monitoring possible. In 1988, the USFWS began a project to identify the quantity and quality of spawning and rearing habitat, usage of habitat, relative production of natural stocks, and stock enhancement potential for chinook salmon in the basin. Now the project has broadened it's scope to include all races of chinook and steelhead.

New River has one of the largest summer steelhead populations in California and a remnant population of spring chinook salmon. The total number of wild summer steelhead in California ranges from 1500 to 4000 fish and the number of spring chinook are less than 1000 fish. The potential for listing these species as threatened or endangered in California under state and/or federal endangered species laws is becoming more apparent with the continued decline of these southern most populations.

Fisheries assessments of New River are funded by the Trinity River Fish and Wildlife Restoration Act (TRFWRA) (P.L. 98-541). Studies underway include assessment and monitoring of habitat used by juveniles and adults, spawner assessment, and monitoring of juvenile outmigrants. Additional information on spawning runs will be acquired after the installation and operation of a resistance weir in the fall of 1991. Recommendations to enhance stock production will be proposed following the project's completion in March of 1993.

STUDY AREA

Description

New River is one of the major tributaries to the Trinity River and is located 70.2 river kilometers (rkm) upstream of the confluence of the Klamath and Trinity Rivers. The map coordinate for the mouth of the New River is T6N R7E S35.

Access to the majority of the river is limited due to it's inclusion in the Trinity Alps Wilderness Area, the steep canyon walls, and areas of private ownership. Main access roads to New River are Highway 299 and the Denny road at Hawkins Bar. The Denny road parallels the river for approximately 27 km along the steep canyon walls. Access to the river is via private land until the public campground areas near Denny (rkm 18.5). After Denny, the road continues back into USFS land for about 5 km where it branches into short routes that end at the New River, Jim Jam, and East Fork trailheads. All access thereafter is nonmotorized.

Currently, there are private landowners and mining claimants along the length of the river; however, the town of Denny is the only section of the river with a concentrated human population (population 25 - 50). The National Forest Service has jurisdiction over the majority of land in the area.

Salmonid species of the basin are spring chinook salmon (Oncorhynchus tshawytscha), rainbow trout (O. mykiss), and summer and winter steelhead (O. mykiss). Fall chinook runs were thought to occur in the basin; however, their existence has not been confirmed. Approximately 80.5+ km of the New River drainage is accessible to adult steelhead and provides excellent nursery areas for the juveniles. Investigations are presently being conducted to evaluate the spring chinook and steelhead populations and their habitat use in the drainage. The New River population of summer steelhead is claimed to be one of the largest in California (CDFG files 1977-1988). Other known fish species of the drainage include speckled dace (Rhynichthys osculus), Klamath small scale suckers (Catostomus rimiculus), and the Pacific lamprey (Lampetera tridentata).

History

The New River drainage has been extensively gold mined and a few areas show scars of logging and fires. Gold was discovered in the area in 1848 and mining began in 1851. Early settlers were Anglo-Americans, Europeans, and then Chinese. In the 1870's mining waned, but by 1880 a second gold rush had begun. The second wave of mining endured until the early 1900's, then the last town, Old Denny, was abandoned in 1920 (USFS 1989).

Numbers of steelhead in the early 1900's are unknown, but local residents claim that the population was so large that numerous fish used small, intermittent streams and pools were "so black with fish you couldn't see the stream bottom". Fish stocking occurred for steelhead in the 1930's and 40's, coho salmon (O. kisutch) in 1968, and chinook salmon in 1979 (Table 1). There is no present evidence or record of coho salmon returns to the basin.

The flood of 1964 had a dramatic effect on the instream habitat of the mainstem New River. After the flood event, there was a lack of pools and streamside canopy which elevated water temperatures and, subsequently, impacted the runs. Thomas (pers. comm.) stated, " New River was like a sidewalk from the confluence of Virgin and Slide Creeks to the mouth".

In 1980, New River was declared as one of the National Wild and Scenic Rivers. The Trinity Alps was designated as a wilderness area in 1984. Close to 68 percent of the New River watershed is within the wilderness boundaries and moderate recreational use occurs in the summer months when average air temperatures are between 29 and 35 degrees Celsius (°C) daily and -4 to 7°C nightly. Water temperatures can be as low as 2°C in the winter and to a high of 24 °C in the summer (Figure 1).

Table 1. Stocking history of the New River drainage.

Date	Species	Size	Number	Hatchery
1932	Rainbow Trout	Unknown	15,000	Unknown
1933	Rainbow Trout	Unknown	15,000	Unknown
1933	Steelhead	Unknown	5,000	Unknown
08-03-38	Steelhead	43/oz.	30,300	Prairie Creek
07-27-39	Steelhead	44/oz.	50,200	Prairie Creek
07-17-41	Steelhead	41/oz.	30,340	Mt. Shasta
07-21-42	Steelhead	42/oz.	24,320	Mt. Shasta
1968	Coho	16/oz.	72,000	Trinity
10-30-79	Spring Chinook	9.2/lb.	1,380	Trinity
10-31-79	Spring Chinook	9.0/lb.	1,800	Trinity

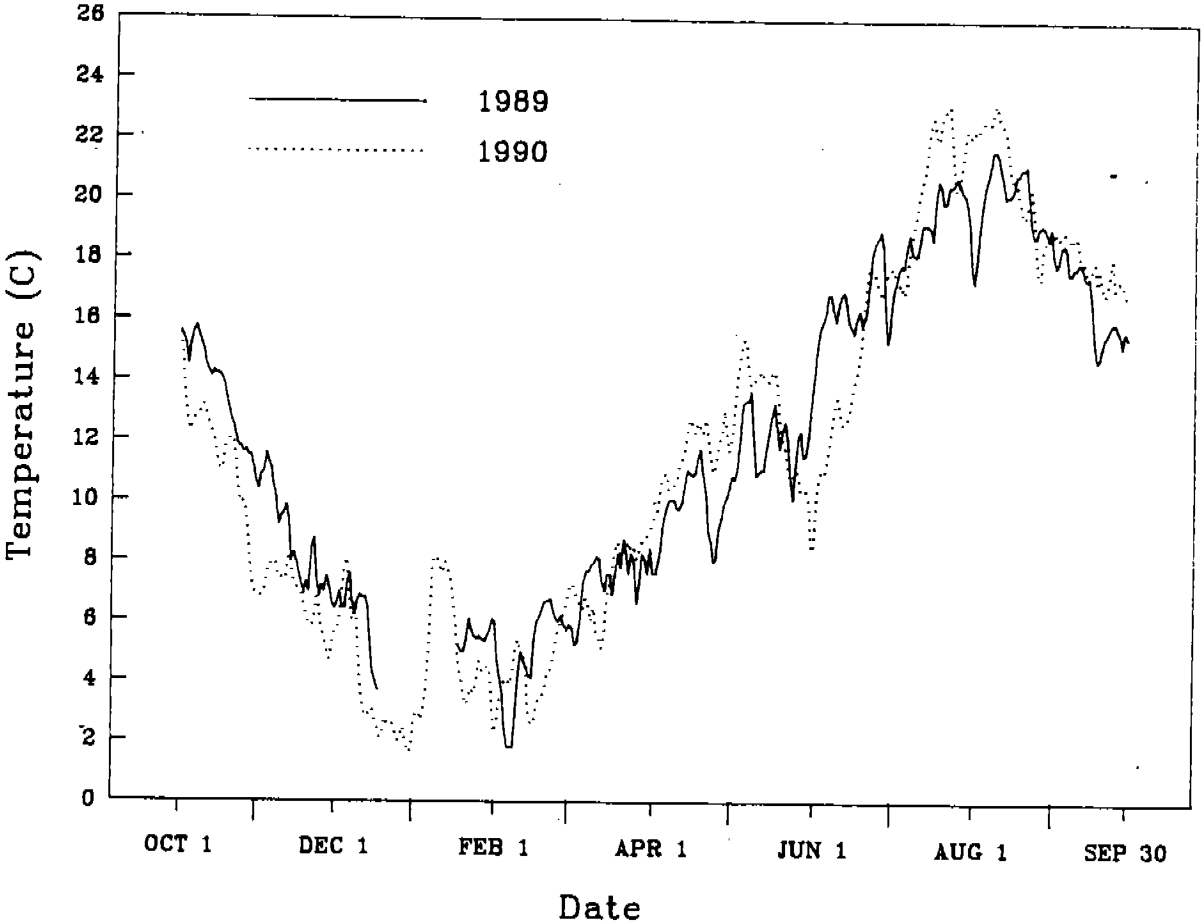


Figure 1. Mean daily water temperatures for 1989 and 1990 water years (October 1 – September 30).

Channel Morphology/Geology/Hydrology

New River is a fifth order stream that flows in a southwesterly direction through deeply incised, "V" shaped canyons. Elevation increases from 213 m at the mouth to 1,646 m in the headwaters. Channel morphology consists of an average stream width of 9 m, average depth of 1.07 m, with some pools as deep as 5.5 - 6.1 m. Stream gradient averages 1.2 % and the pool to riffle ratio is 20:50 (Freese and Tayler 1979). The primary sources of stream cover are boulders, bedrock ledges, pool depth, and surface turbulence. Instream woody material, as well as vegetative canopy, is lacking throughout most of the river. Douglas fir, maple, digger pine, madrone, and California black oak trees make up the overstory vegetation upslope. Understory riparian vegetation includes herbaceous shrubs, alders, and willows.

New River drainage is located in the Klamath Mountains Geomorphic Province. Sedimentary metamorphic rocks comprise 80% of the rock types of New River drainage and igneous rocks constitute the remaining 20%. Predominant rock formations of the area are of the Rattlesnake Creek Plate type. Tectonic mixing is suspected in this unit due to the highly variable rock compositions. The Ironside Mountain Batholith contains the lower reaches of the river and the western side of the drainage up into the headwaters. This area is underlain by hornblende diorite which is known to be highly unstable (Young 1978).

Boulder and bedrock banks are common throughout the system and bank slopes vary from 25 to 100 degrees. Bank degradation is minimal but is present where logging or burning has occurred. Pools, bank slides, and recently dredged (mined) areas contain most of the fine sediment and siltation found in the drainage. Compaction is relatively slight.

New River, predominantly a rain influenced basin, drains a total area of 173 square miles and can be characterized a flashy water system. Current average annual precipitation is 102-127 cm. The heaviest precipitation normally occurs between December and April with peak discharge normally in February or March. The USGS recorded a peak discharge of 45,000 cfs on December 22, 1964; however, annual high flows have averaged 1,000 to 1,125 cfs in January, February, and March of 1989 and 1990. Low flows have been as low as 18 cfs (October 1961), but have averaged 24 to 72 cfs in August, September, and October of 1989 and 1990 (Figure 2).

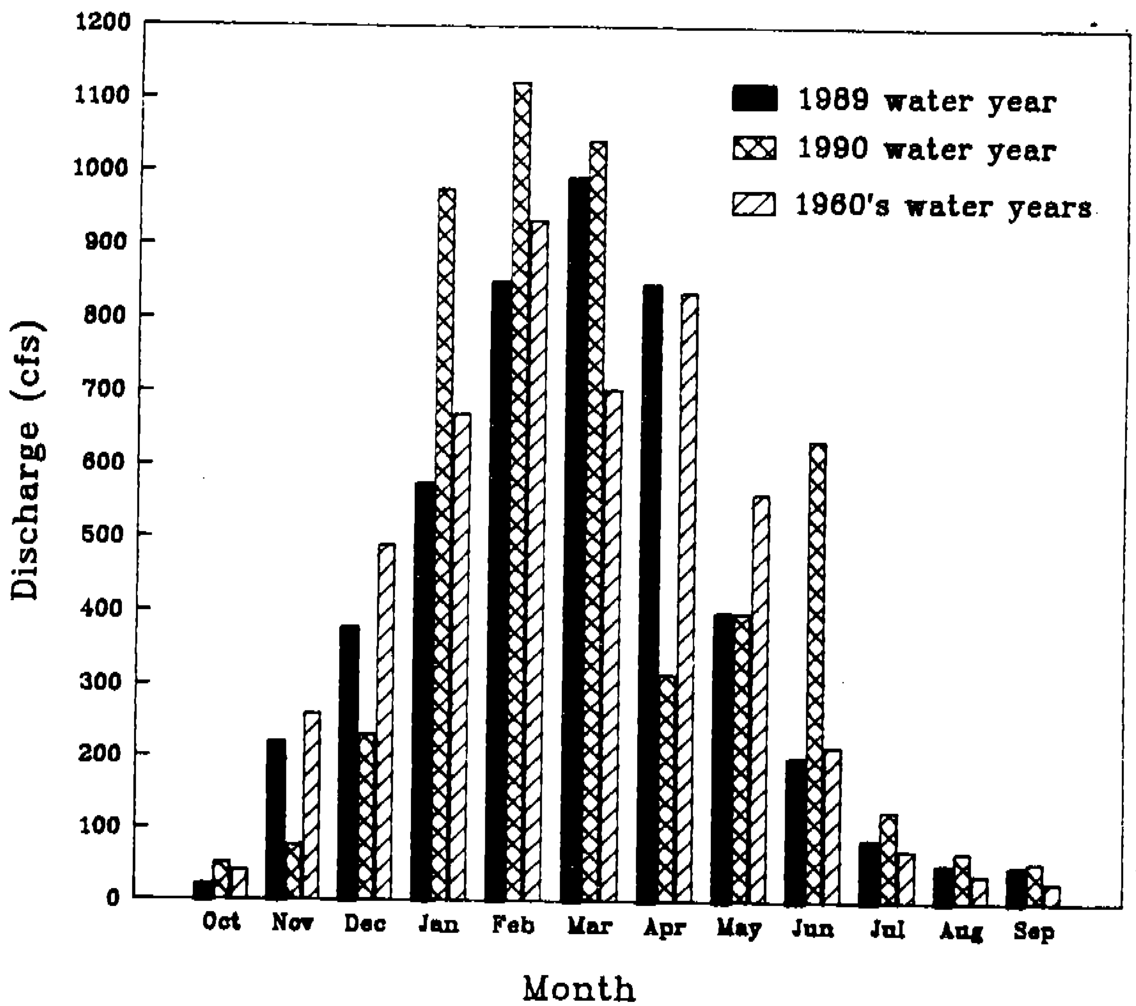


Figure 2. New River's average monthly flows for 1989, 1990, and 1960's water years (October 1 – September 30).

MATERIALS AND METHODS

Stream Physical Measurements

Water Temperature Monitoring

Stream temperatures were monitored beginning August 21, 1988 by use of a Ryan Instruments TempMentor temperature recorder (Model #RTM) located at river kilometer (rkm) 3.5. Temperatures were recorded continuously at two hour intervals throughout the investigation. The TempMentor was anchored by use of a cement, cobble casing which resembled the river bottom. This casing also camouflaged the tempmentor to preclude disturbance. Average daily stream temperatures for the 1989 water year (October 1, 1988 to September 30, 1989) and the 1990 water year (October 1, 1989 to September 30, 1990) were obtained along with daily maximum and minimum temperatures.

Discharge

A staff gaging station was constructed at rkm 3.3 by use of a staff gage with anchor straps and bolts. A river crest gage (1" polyethylene tubing) was attached to the gage with the bottom open end submerged in water. Fine burned cork shavings were placed inside the tube and washed down to the meniscus. The raising and then lowering of the water level left a line of cork resin indicative of the peak discharge height. Staff gage height and discharge were correlated using log to log transformed data in linear regression analyses (Figure 3).

$$Y(\text{discharge}) - 10^{1.35 + 3.05(\log X + 1)} - 1$$

$$r^2 = 99.92\%$$

Discharge was obtained at a range of flows by use of a Scientific Instruments, INC. Price AA Current Meter. Flows were taken across a permanent transect line (rkm 4.1) at 5 foot intervals during a variety of discharges. Once the gage to discharge model was derived, gage heights were used to estimate the stream's discharge for the remainder of the investigation.

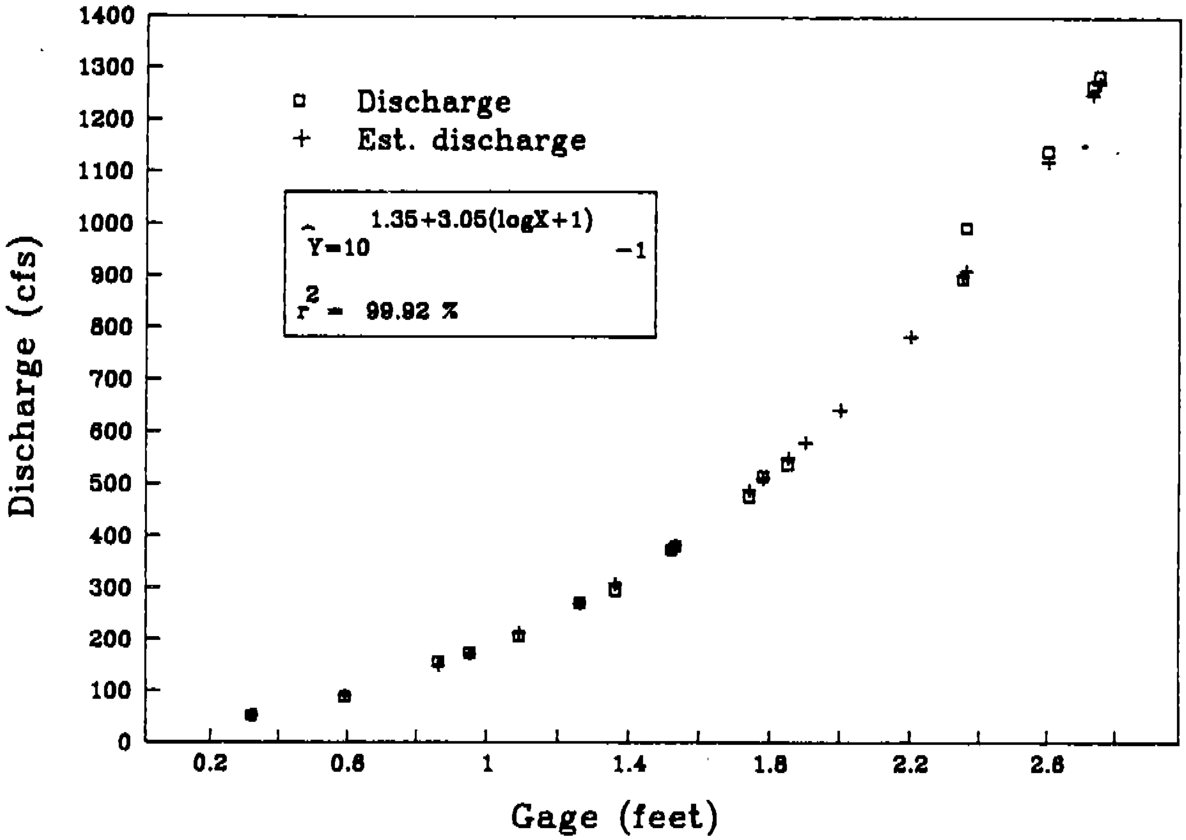


Figure 3. Gage to discharge relationship in New River (rkm 3.3).

Stream Classification

Channel Typing

The entire mainstem of New River (33.8 kilometers), East Fork of New River (to rkm 11.8), Virgin Creek (to rkm 7.2), Slide Creek (to rkm 4.8), and Eagle Creek (to rkm 1.6) were categorized by channel types (Rosgen 1985). Channel typing was based on the following morphological criteria: channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, entrenchment of channel and confinement of channel in valley; and landform features, soil erodibility, and stability (Appendix A). The mainstem of New River was divided into reaches based on changes of the channel types. These reaches were used when establishing permanent index reaches; assessing rearing habitat, and identifying habitat types.

Habitat Typing

Habitat typing, using methods presented originally by Bisson et al. 1982 (modified by McCain et al. 1990) was completed for the mainstem of New River (to the confluence of Virgin and Slide Creeks at rkm 33.8), East Fork of New River (to mouth of Cabin Creek, rkm 11.8), Virgin Creek (to rkm 7.2), Slide Creek (to rkm 4.8), and Eagle Creek (to rkm 1.6). Habitat unit types were identified by the observer using the Pacific Southwest Region Habitat Typing Field Guide (USDA-USFS) based on 24 habitat unit types (Appendix B). Mean length and widths were taken using calibrated range finders (Ranging Inc. 620, 123X) for each habitat unit encountered. A systematic approach was used to determine which units were sampled for physical characteristics. At each change in channel type, units were tallied and every fifth unit of each specific unit type was measured for mean length, mean width, mean depth, maximum depth, and depth at pool tail crest. Percent stream shade, percent pool instream cover (under cut banks, small woody debris, large woody debris, terrestrial vegetation, aquatic vegetation, white water, boulders, bedrock ledges, and water depth), cover complexity, percent substrate composition (bedrock, boulder, cobble, gravel, sand, and fines), percent embeddedness, percent exposed substrate, time, temperature, and comments were also recorded for each unit measured. Every third unit of infrequent habitat types were sampled to deter the likelihood of not being represented among measured units. Snorkel counts were not conducted for a relative abundance estimate of juveniles in each habitat unit type. Relative abundance estimates and habitat use by juveniles were obtained from sampling in index areas (will be reported in 1991 Progress Report) and trapping of emigrating juveniles. In this way, we were able to accelerate the habitat typing operation and allow time for other investigations on the river.

Total areas and total volumes of habitat types were estimated from the expansion of the 20% sampled (widths and depths) within each channel type. Mean substrate percentages, maximum depths, percent cover, percent exposed substrate, percent shade, and substrate embeddedness were also summarized. Percent total lengths for each channel type encountered was also calculated.

Habitat Evaluations

Spawning Habitat Availability

Estimates on spawning habitat availability were begun the fall of 1988 and completed in fall 1989 on the mainstem of New River. The fall time period was chosen in order to include all potential spawning gravel inundated at the time chinook normally spawn. Flows ranged from 200-400 cfs in 1988 and 100-250 cfs in 1989 during data collection. Information obtained during these surveys included area measurements, substrate composition estimates, and depth measurements. Percentages were estimated for large cobble (15-30cm); small cobble (8-15cm); large gravel (3.5-8cm); small gravel (0.5-3.5cm); and sand, silt, and clay (<0.5cm). Substrate composition and depth measurements were taken at 3-5 points across transect lines within the measured area. The number of transects varied from 2-5 depending on the size of the area. Potential spawning gravels were identified for the "optimum" size range (0.5 - 15cm) as described by Briggs (1953) and Reiser and Bjornn (1979). Estimates on the amount of spawning gravels available per reach (different channel types) and for the entire mainstem were calculated. Selection of spawning habitat areas were subjective as experienced field personnel selected the areas to be measured based on general knowledge of depths and velocities preferred by spawning chinook salmon. Spawning depths of spring chinook redds observed in New River ranged from 0.20 to 0.35 meters (mean = 0.26, n = 11). Water velocities ranged from 1.01 to 1.30 feet per second (mean = 1.15, n = 4). Spawning depths for spring chinook reported by Reiser and Bjornn (1979) were greater than or equal to 0.15 meters and velocities ranged from 0.46 to 2.99 feet per second. The range of potential spawning pairs was calculated by multiplying the average redd sizes of New River (7.5 m^2) and mainstem Trinity River (4.6 m^2) and then dividing the product in half to allow for redd separation. Although subjective, this information does give a reasonable estimate of potential chinook spawning habitat in mainstem New River.

Available Rearing Habitat

A systematic reach approach was used to assess rearing habitat on the mainstem of New River during the spring of 1989 after the flows dropped below 500 cfs. Reaches, based on discrete channel type breaks, were identified and each reach was divided into 100 meter sections. One hundred meters were sampled every 500 meters within a reach. The first 100 meters to be sampled was randomly selected within the first 500 meters of each reach. Within each 100 meter sampled section, the dominant habitat unit was identified and subdominant units were noted. Mean widths, depths, and maximum depths were measured along evenly spaced transect lines. Percent instream cover, substrate composition (boulder, cobble, gravel, sand, and fines), percent rearing habitat available (for chinook and steelhead), rearing habitat rating (1-excellent to 5-none) were estimated. We noted if the sampled section was representative of the 500 meters from which it was selected. Snorkel counts of juvenile chinook, and steelhead yoy, yearlings, and 2 year olds were recorded for the edge, intermediate, and thalweg areas to obtain relative densities of the juveniles as well as preferences for a particular zone. To gain an idea of the reliability of counts, experienced divers noted their degree of confidence (percent of fish observed) in each count made. The large size of the drainage, limited time, frequent deep pools, and low accessibility precluded the use of electroshocking to calibrate the divers counts. Criteria such as edge water areas, instream cover, and substrate were used to estimate the percent of habitat usable by juvenile chinook and steelhead. Usable habitat was determined for 20 percent of each reach (100 meter/500 meters) and then expanded for the entire reach. Previous snorkel observations in New River have revealed that chinook young-of-year (50 - 60mm) primarily occupy edge habitat during rearing.

In our investigations, available habitat is defined as "usable rearing habitat". Criteria used to identify useable habitat were depth, area, and cover. Percentages were calculated as the proportion of the total area within a 100 meter sample reach that consisted of identified useable (edge) habitat.

Juvenile steelhead were observed in a variety of microhabitat types associated with cover. Young-of-year appeared to use edge habitat most frequently while 1+ and 2+ steelhead were usually found in the faster water (intermediate and thalweg zones). Percent useable rearing habitat for habitat for steelhead was the proportion of total area within a 100 meter sample area that contained cover in the form of surface turbulence, boulders, or instream or terrestrial vegetation.

Population Trends

Summer Steelhead and Spring Chinook Adult Counts

Adult summer steelhead and spring chinook salmon were counted using mask and snorkel during September 1988, 1989, and 1990. Due to hazardous stream conditions in 1988, only a portion of the watershed was surveyed. In September of 1989 and 1990, snorkel surveys for adult steelhead and chinook were completed due to the workable flow conditions. All unit types, with a depth greater than 1/2 meter, were surveyed. Surveys were conducted in Virgin Creek (from Soldier Creek to the mouth), Eagle Creek (from the North Fork confluence to the mouth), Slide Creek (from the confluence of Eagle Creek to the mouth), and the mainstem of New River (from the confluence of Virgin and Slide Creeks to the mouth) (Figure 4). In 1990, the East Fork of New River was surveyed from the South Fork confluence to the mouth. The habitat types where adult summer steelhead were observed in 1990's survey were recorded.

Spring Chinook Redd Counts

Based on results of the different survey methods employed in New River (snorkel counts, carcass counts, redd counts) in 1988, redd counts were found to be the best method in determining potential chinook production. Carcass counts were the least effective method due to the low spawning population and the difficulty of locating carcasses. Redd surveys were conducted in 1988, 1989, and 1990 for the mainstem of New River (33.8 kilometers) biweekly from mid October through late November. Surveys in November were used to assess the possible presence of fall chinook. Map locations of redds observed

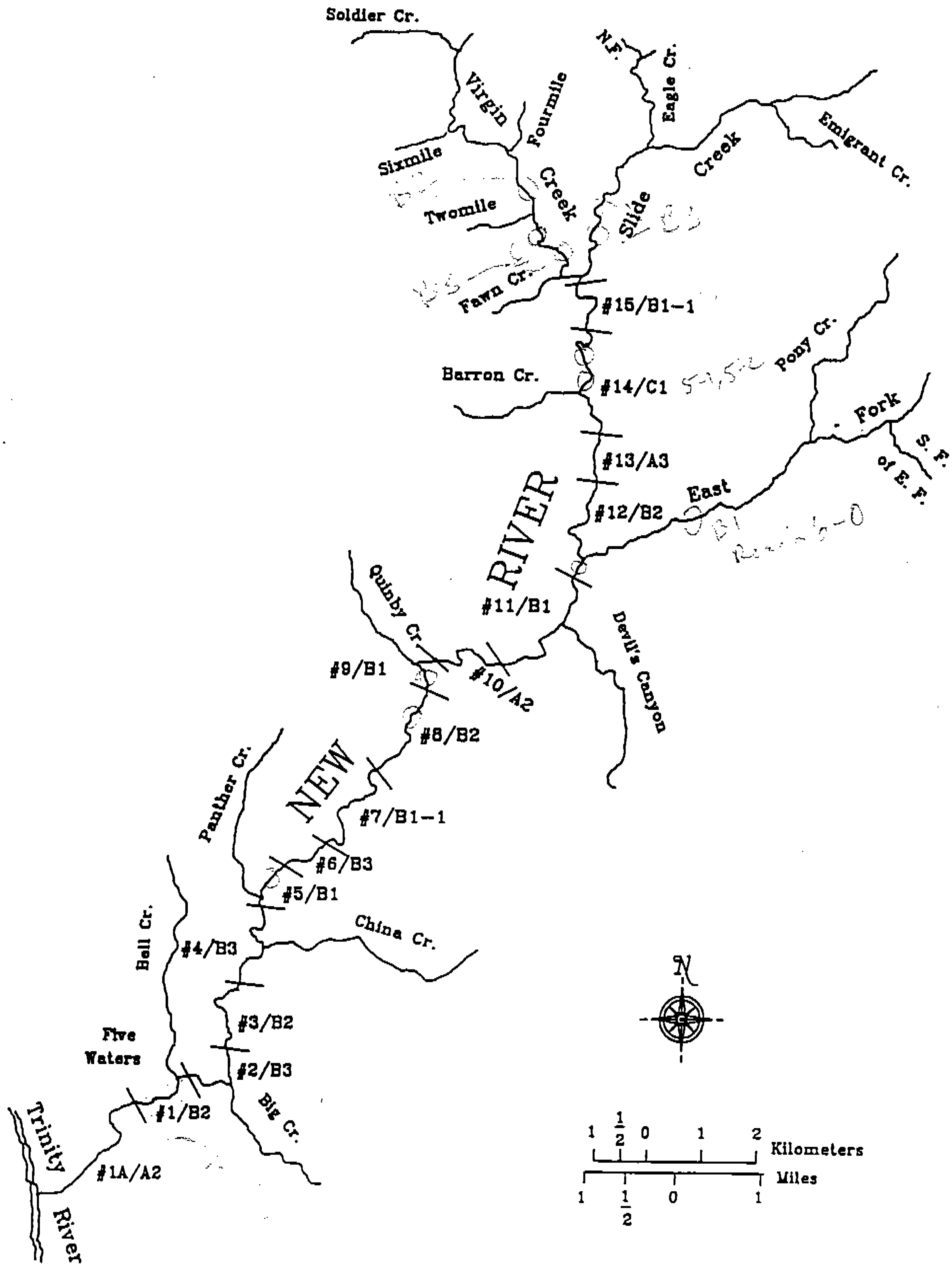


Figure 4. Map of New River including reach breaks.

during 1988, 1989, and 1990 were summarized. On a majority of redds, lengths, mean width, depth of pit, and depth over mound were recorded. Areas used by the chinook were averaged for the calculation of spawning habitat availability.

Juvenile Trapping

A rotary screw trap and frame net trap were used for the capture of emigrating juvenile salmonids during 1989 and 1990 (Figure 5). The rotary trap is comprised of a fiberglass spiral vein enclosed in a funnel shaped aluminum pipe ring and galvanized hardware cloth enclosure. An aluminum pipe though the focus of the opening provides a spinning medium. Two aluminum encased styrofoam pontoons support the funnel and livebox as well as providing floatation and a walkway. The plywood cross braces allowed a working medium and an access to the live box. The trap's circular opening has a diameter of 2.44 meters and is capable of operating up to a depth of 1.22 meters. Water that passes though the trap's opening and against the spiral veins causes the funnel to spin along its axis. All fish entering the trap are sectioned off from the river and passed through the auger like veins into a holding box at the rear of the structure. The trapping season for 1989 was April 7 - July 17 and 1990's season was April 5 - November 19. The trap was located both years at rkm 3.75. All fish captured after a nights fishing were then separated into species and tallied. Lengths and displacements were taken from random samples of up to 50 fish of each salmonid species and age class. Scales were taken from up to 25 juvenile steelhead to determine the proportion of yoy, yearlings, and 2+ aged fish. Fish were also examined externally for any symptoms of diseases and parasites. Flows were taken at the right, center, and left side of the trap mouth with a Price AA current meter. Flow through the trap was correlated to stream discharge to derive a percent of the river discharge sampled. Mark/recapture estimates and the percent discharge sampled were used to project the amount of

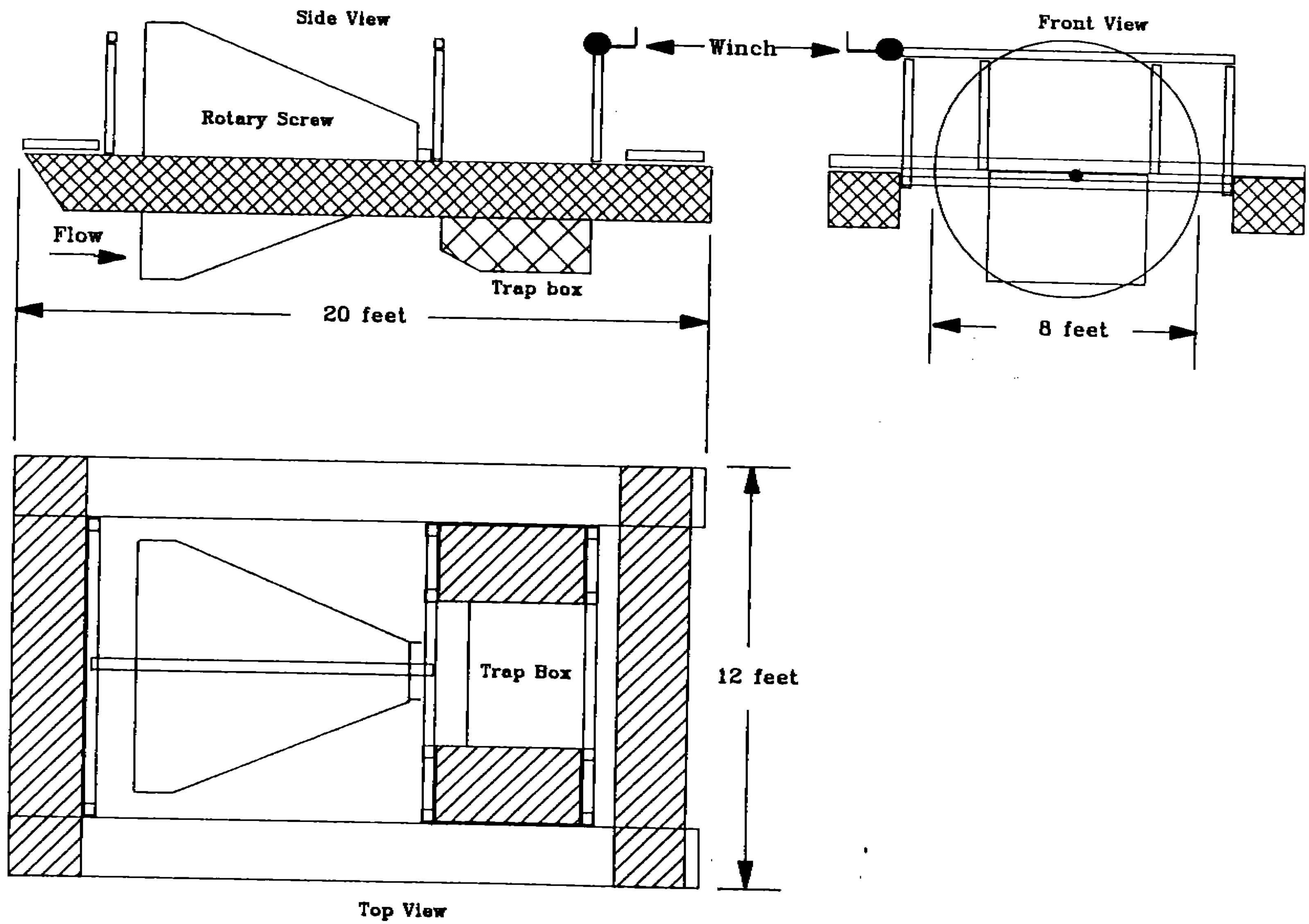


Figure 5. Views of the rotary screw juvenile trap used on New River.

juvenile chinook and steelhead passing the trapping area per unit time (trapping efficiency). Marks applied to the salmonids during efficiency tests varied from bismarck brown dye to fin margin clips. Fin margin clips were used for the majority of estimates since stress, fatigue, and disorientation as a result of the dying procedure confounded results. Mark/recapture tests were preformed weekly on all juvenile chinook captured and on a proportion the steelhead parrs and smolts. Due to the high variance accompanying the mark/recapture tests, relative abundance estimates of emigrating salmonids were derived by the expansion of trap nights fished and percent discharge sampled. Peak migrations were determined for the juvenile chinook and steelhead and with a projected number of individuals. Juvenile chinook and steelhead length and displacement relationship curves were derived by using log transformed linear regression analyses. Length frequency histograms, average length - date, and length - age relationships were derived for juvenile chinook and steelhead for the trapping seasons. Juvenile steelhead were divided into the parr and smolt categories based on the presence or lack of parr marks, silvery coloration, and the looseness of scales.

A frame net trap (1.5 x 3 meter opening) was placed above the confluence of the East Fork and the mainstem to monitor fish movement and the timing of emergence of salmon and steelhead. Captured fish were separated by species and age class and enumerated. Lengths and displacements were taken from up to 50 fish of each species. Scales were taken to differentiate between the steelhead age classes. Scales were mounted for each sample between a cover slip on a microscope slide and aged using a microfiche enlarger. The trap operated from April 7 - June 9, 1989. In 1990, the frame trap was placed in the East Fork of New River approximately 300 meters from the mouth from March 28 - May 22 to determine whether chinook production occurs in the East Fork. All fish captured were measured and enumerated.

RESULTS AND DISCUSSION

Stream Physical Measurements

Water Temperature Monitoring

Mean daily temperatures were recorded at river kilometer (rkm) 3.5 for the 1989 and 1990 water years (Oct 1 - Sept. 30) (Figure 1). The tempmentor was not operating from November 19, 1988, through January 17, 1989. Average daily water temperatures in water year 1989 ranged from a low of 1.8°C (35.2°F) in February to a high of 21.7°C (70.7°F) in August. Average daily water temperatures in water year 1990 ranged from a low of 1.6°C (34.9°F) in December, 1989, to a high of 23.3°C (73.9°F) in August, 1990.

The unusually low precipitation observed in the basin in water year 1990, and again this year, could conceivably reduce normal instream winter water temperatures due to only incidental rainfall/snow melt mixing. Conversely, the low water conditions may increase average summer temperatures. Reiser and Bjornn (1979) reported that the recommended temperatures for the incubation of spring and fall chinook to be between 5.0 and 14.4°C. The low temperatures observed in New River during December and February were below recommended temperatures. The high temperatures observed in August of 1989 and 1990 were above the temperature criteria (3.3 to 13.3°C) for the successful upstream migration of spring chinook, but below the sustained lethal limit of 27°C. Temperatures above the upper limit have been known to stop the migration of fish and alter the timing of migration (Reiser and Bjornn 1979). Deep holding pools, as observed in New River, may provide cool holding habitat for spring chinook and summer steelhead adults (Reiser and Bjornn 1979, Moyle et al. 1989). Potential degradation of the riparian and upslope vegetation by poor land use practices or unusual natural events could cause water temperatures to increase during the summer and adversely impact the already less than optimal conditions for salmonids. Water temperatures remained within the range for successful juvenile steelhead production. The high water temperatures experienced in August could slow the growth of steelhead juveniles due to increase of metabolism, although these high temperatures are not sustained for a long duration.

Discharge

Discharge was monitored throughout the 1989 and 1990 water years and monthly averages, along with averages from the 1960's (USGS 1970) (averages from the 1970's and 1980's are unavailable), are presented in Figure 2. Average monthly flows ranged from 30 - 40 cfs in the late summer, early fall to 1100 - 1200 cfs in the winter and spring. Peak flows, as high as 10,000 cfs, were determined from the river crest gage on January 7, 1990. Peak flow on December 22, 1964, was 45,000 cfs (USGS 1970).

The relationship between stream flow and food production, cover, and microhabitat needs of fish have been documented (Reiser and Bjornn 1979, Kraft 1972, Nickelson and Reisenbichler 1977). Decreased flows noticed in 1990 may result in the loss of critical microhabitat which could increase intra- and inter-specific competition between salmonids for limited food and space. This increase in competition could potentially lower production (biomass), promote predation, and alter downstream migration patterns.

Stream Classification

Channel Typing

The mainstem New River and a portion of its major tributaries (East Fork, Virgin Creek, Slide Creek, and Eagle Creek) were identified as to channel types based on Rosgen 1985 (Appendix A). The mainstem New River was divided into 16 reaches based on channel type breaks (Figure 4 and Appendix C).

Seven channel types were observed in the mainstem (A2, A3, B1-1, B1, B2, B3, and C1) with B being the most common (Figure 6). Elevations increase from 700 feet at the mouth of New River to 2,000 feet at the Virgin and Slide Creek's confluence (Figure 7).

Habitat Typing

Habitat typing was conducted for the mainstem New River from the mouth to the confluence of Virgin and Slide Creeks during low summer flows. In August of 1988, rkm 3.1 (Five Waters Ranch) to rkm 37.6 (confluence of Virgin and Slide Creeks) was completed and the mouth to rkm 3.1 was completed in July of 1990.

A total of 712 units were measured totaling 37.6 kilometers (Table 2). Sixteen of the 24 habitat types were observed on the mainstem. Low gradient riffles (LGR) were most frequent followed by bedrock scour (LsBk), boulder scour (LsBo), and mid channel pools (MCP). Percent total lengths were dominated by MCP, LsBk, LGR, and LsBo (Figure 8). The total surface area for the mainstem, excluding side channels, was estimated to be 498,439 square meters and the total estimated volume at summer low flow is 437,395 cubic meters. MCPs, LsBrs, and LGRs contained the greatest surface areas while MCP and LsBk pools had the greatest volumes.

Habitat type varied among unique and similar channel types (Appendix C). High gradient, deeply entrenched, and well confined channels (A2 and A3) have a small assortment of habitat types and a relatively large percent of cascades, pocket water, and bedrock and boulder associated pools while moderate gradient, moderately entrenched, and moderately confined channels (B1 and B2) are affiliated with a higher diversity of habitat types dominated by LGRs, LsBk, and LsBo.

The majority of the pool habitats contained sand mixed with small gravel. The deep pools located in New River are large collection basins for small substrate created by suction dredge mining, recruitment from the stream banks, and mass waste areas.

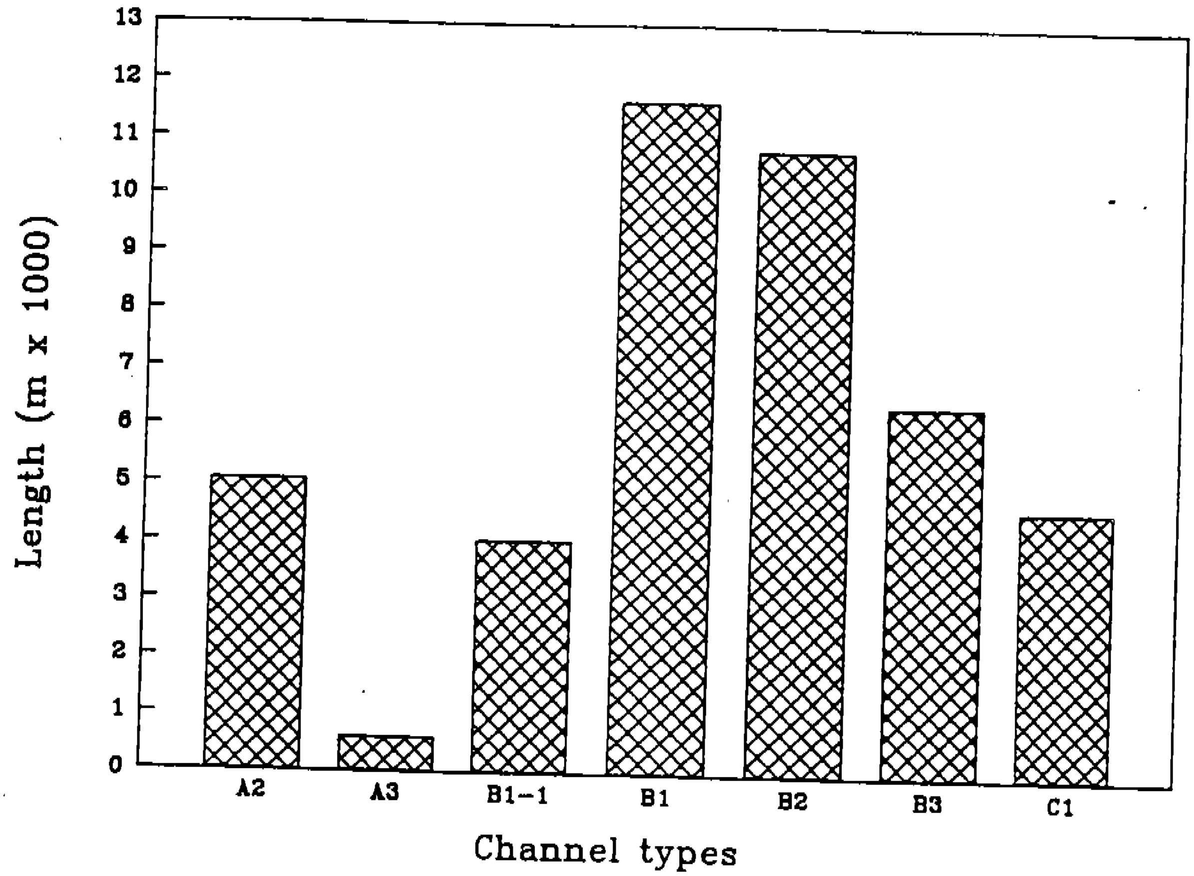


Figure 6. Channel types observed in the mainstem New River.

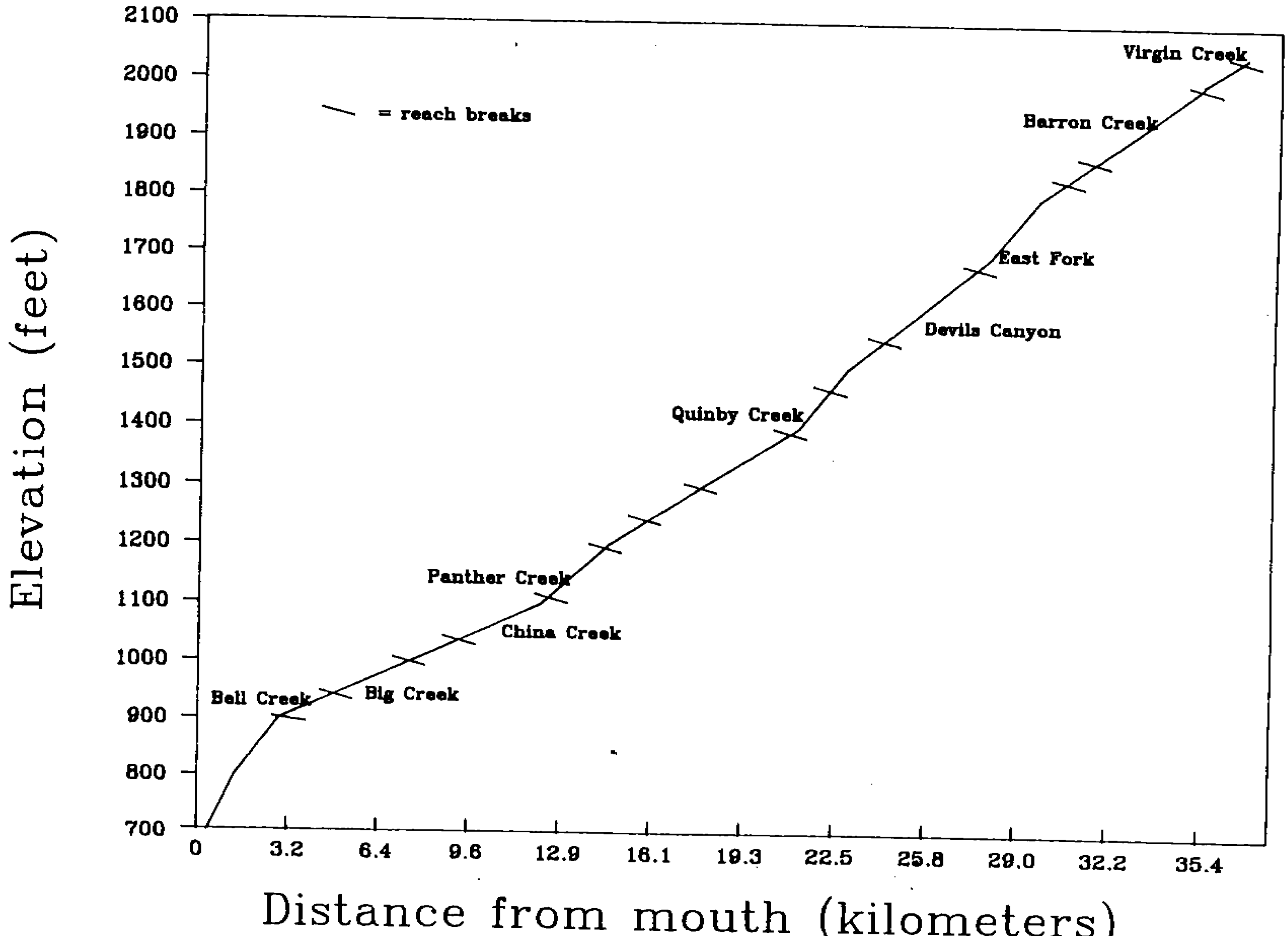


Figure 7. Longitudinal profile of New River.

Table 2. New River habitat typing summary.

Habitat Type	Acronym	Units Observed (n)	Mean Length (m)	Mean Width (m)	Total Length (m)	Mean Depth	Mean Maximum Depth (m)	Mean Area (m^2)	Est. Total Area (m^2)	Est.Total Volume (m^3)
1	LGR	166	45.2	12.8	7,237.7	0.26	0.61	608.6	97,382.9	28,431.3
2	HGR	29	32.0	12.9	927.4	0.43	0.80	407.7	11,822.3	5,065.2
3	CAS	58	21.2	11.1	1,228.6	0.49	1.04	237.4	13,767.8	6,799.9
8	TRC	1	36.0	9.2	36.0	ns 1)	ns	ns	331.2	ns
9	PLP	7	22.6	10.8	158.5	0.90	1.90	237.3	1,661.4	1,495.3
12	LsBk	112	63.1	13.4	7,065.9	1.13	2.30	867.6	97,713.7	111,061.6
14	GLD	41	61.0	13.1	2,502.2	0.39	0.80	849.0	34,807.9	13,924.5
15	RUN	32	29.4	11.2	940.7	0.33	0.90	338.5	10,830.3	3,306.1
16	SRN	18	68.2	12.1	1,227.0	0.27	1.20	860.2	15,483.9	4,607.4
17	MCP	85	93.0	13.4	7,905.8	1.65	3.20	1,258.0	106,928.0	179,192.0
19	CCP	2	49.5	9.8	99.0	ns	ns	501.4	1,002.7	ns
20	LsBo	93	47.6	11.7	4,422.3	0.66	1.40	575.0	53,471.0	37,295.2
21	POW	59	46.4	12.3	2,740.1	0.40	0.90	586.1	34,578.3	14,083.1
22	CRP	12	87.3	16.3	1,047.0	1.83	3.87	1,455.0	17,460.2	32,133.3
23	STP	2	27.5	18.0	55.0	ns	ns	486.0	972.0	ns
24	BRS	1	20.5	11.0	20.5	ns	ns	225.5	225.5	ns
				Totals	37,613.7				498,439.1	437,394.9

1) ns = no sample

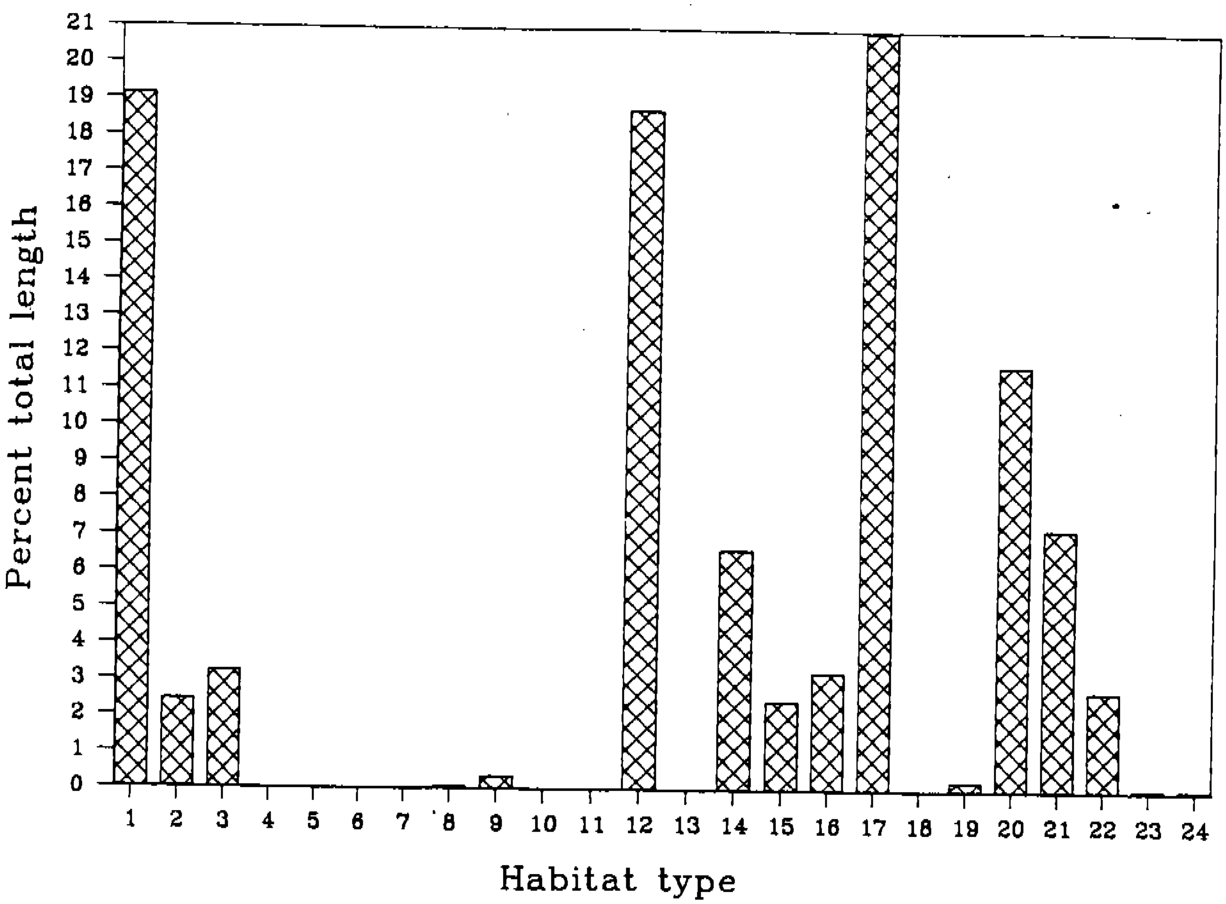


Figure 8. New River habitat types and percent total length.

During years of low precipitation, a reduction of flushing flows and the accumulation of sand in the tail outs of the pools could have a negative influence on the incubation success of salmon and steelhead eggs often located in those areas. Mean substrate embeddedness for MCP was 47% and 68% in corner pools (CRP) (Table 3). Instream cover is limited in the pool habitat types to the edges, heads, and tails. The mean percent pool cover ranged from a low of 16% in the LsBk pools to a high of 31% in the MCPs. The absence of small and large woody debris and large substrate may contribute to the lack of coho salmon in the drainage, since coho juveniles are strongly orientated to instream pool cover. A total of 72,000 coho were released in the mainstem in 1968, but no coho have been observed in this study. High percentages of bedrock were also observed in the MCP and LsBk. This may be indicative of natural functions in the watershed caused by frequent flood events that scour to bedrock depositional areas of small sediment. After the 1964 flood event, all the pools were filled in with unarmored substrate and have slowly scoured out through time. Early mining practices in sections of the river included the extraction of all substrate from the river floor down to the bedrock. Tailings of cobble and boulders are still present along the stream banks.

Habitat Evaluations

Chinook Spawning Habitat Availability

New River supports a small run of spring chinook. Redd counts in 1988, 1989, and 1990 were only a meager 16,14, and 11, respectively. Spring chinook are known to enter the Klamath River as early as March (USFWS 1987) and move into New River with the spring rains and snow-melt flows. Estimated spawning habitat in the mainstem based on all measured areas totaled 21,629 square meters (Table 4).

A large proportion (47%) of potential spawning habitat is

Table 3. New River substrate and cover summary.

Habitat Type	Acronym	Units Observed	Mean %Sand	Mean %Gravel	Mean %Cobble	Mean %Boulder	Mean %Bedrock	Mean %Cover	Mean %Shade	Mean Exposed Sub-strate	Mean Substrate Embed-dedness
1	LGR	160	8.8	21.1	47.2	21.9	1.1	46.3	10.7	10.3	15.5
2	HGR	29	6.0	15.0	41.0	35.0	3.0	59.0	8.0	13.0	11.0
3	CAS	58	3.6	7.1	17.1	58.6	13.6	40.7	27.9	15.0	2.8
8	TRC	1	ns	ns	ns	ns	ns	ns	ns	ns	ns
9	PLP	7	20.0	5.0	10.0	60.0	5.0	50.0	5.0	0.0	10.0
12	LsBk	112	32.8	22.6	23.0	11.1	10.4	16.1	19.5	1.4	37.8
14	GLD	41	14.3	35.0	43.6	6.4	0.7	6.9	8.6	7.6	22.1
15	RUN	32	15.0	27.5	36.7	13.3	7.5	9.2	12.5	2.7	16.7
16	SRN	18	11.7	28.3	30.0	25.0	5.0	31.0	31.0	4.3	15.0
17	MCP	85	29.0	19.3	16.0	17.0	15.7	30.7	18.0	1.7	45.3
19	CCP	2	ns	ns	ns	ns	ns	ns	ns	ns	ns
20	LsBo	93	23.3	23.9	25.8	24.4	2.5	20.8	15.3	4.9	31.1
21	POW	59	10.0	15.8	39.6	32.3	2.3	30.8	21.9	13.5	14.6
22	CRP	12	70.0	13.3	6.7	3.3	6.7	26.7	35.0	0.0	68.3
23	STP	2	ns	ns	ns	ns	ns	ns	ns	ns	ns
24	BRS	1	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 4. Estimated chinook spawning habitat (m^2) on the mainstem of New River.

Stream Reach	River kilometer (rkm)	Channel Type	Measured Spawning Habitat (m^2)
1A	0.0 - 3.1	A2	1,105
1	3.1 - 5.3	B2	3,625
2	5.3 - 7.2	B3	1,587
3	7.2 - 9.5	B2	2,547
4	9.5 - 12.7	B3	1,289
5	12.7 - 14.6	B1	39
6	14.6 - 15.7	B3	102
7	15.7 - 18.1	B1-1	559
8	18.1 - 20.9	B2	1,117
9	20.9 - 22.4	B1	122
10	22.4 - 24.4	A2	0
11	24.4 - 28.1	B1	1,184
12	28.1 - 31.0	B2	1,855
13	31.0 - 31.7	A3	113
14	31.7 - 35.7	C1	5,585
15	35.7 - 37.2	B1-1	800
		Total	21,629

located in the lower portion of the mainstem from rkm 2.4, in the Five Waters area, to rkm 11.3 (Panther Creek). Forty percent of all chinook redds in 1988 and 1989 were located in this area; only 2 redds (18%) were located in this area in 1990. Comparatively little spawning habitat (14%) is found between Panther Creek and the East Fork.

Of the remaining spawning habitat, 26% occurs in stream reach 14. The average chinook redd size in New River (n=10) in 1988 and 1989 was 7.5 square meters (range 3.6 to 12.3 square meters). USFWS (1988) estimated the average chinook redd size in the mainstem Trinity River at 4.6 square meters. Doubling these figures to allow for redd separation provides two estimates of space required per chinook spawning pair (15 and 9.2 square meters). Using the estimates of measured spawning habitat and the two estimates of area required per spawning pair gives a range of potential chinook spawning pairs from 1,442 to 2,351 for the New River mainstem if all habitat available was used. Spawning surveys conducted for 1988, 1989, and 1990 suggested that only 11 to 16 spring chinook spawning pairs were using the drainage.

Increased fine sediments located at the tail of pools has been observed during spawning ground surveys and may have a negative impact in the embryonic development of the spring chinook eggs. Dredge operations cease in September, but remnants of fine sediment tailings still exist through the spring chinook spawning season (late September through early November). Potential impacts associated with dredging operations (sediments and poaching impacts) should be monitored in future studies.

Rearing Habitat

Juvenile Chinook

Chinook rearing habitat in New River is restricted by steep bedrock walls, limited edgewater areas, lack of instream woody cover, limited stream side vegetation, and the low abundance of side channels (1786.5 meters, 4.7% of total length of the mainstem). After emergence, juvenile chinook are known to select very shallow water over a variety of substrates. As they grow older they continually shift their distribution to deeper faster water (Everest and Chapman 1972). Chinook begin to emerge from the gravel in late February through March and the majority of the fingerling/smolts are out of the river by late July. Since there are only a few juveniles (<4000, based on average of 13 redds and 10% survival) and they use the drainage for a total of 4-5 months, rearing habitat is probably not limited for this population.

Rearing habitat available to chinook was estimated to be 34,168 square meters in the mainstem New River from rkm 3.3 to the confluence of Virgin and Slide Creeks at flows between 200 and 400 cfs. The mainstem was divided into reaches based on channel type breaks. Total area available for reaches 1 - 15 (rkm 3.3 - 44) are presented in Figure 9. This total area estimate was expanded from the actual area sampled within each reach (20%, 100 meters of every 500 meters) to the entire mainstem. The placement of the majority of juvenile chinooks was determined by snorkel observations during May and June of 1989. From May 11 through June 12, juvenile chinook are around 60 mm and are primarily located in the edge area (68% of all chinook) (Figure 10). As they increased in size, juvenile chinook began mixing with juvenile steelhead in the intermediate and thalweg zones, although a majority of the chinook actively emigrated during the night. Small schools were also observed in deep pools (3-4 meters deep) taking cover (depth) near the sandy bottom where few juvenile steelhead were observed. The percent of the rearing habitat available during May 11 to June 12, 1989, is subject to change with increasing or decreasing flows. Discharge during this survey ranged from 200-400 cfs, although discharges have ranged from 30 to 1200 cfs during the rearing periods. Predators within the drainage include mergansers, great blue heron, water snakes, otters, and larger juvenile steelhead. On an occasion, steelhead were observed feeding in the shallow edge microhabitat areas where the majority of the juvenile chinook were located. On an occasion during the emergence period, chinook fry were found in the stomachs of a few of the larger juvenile steelhead trapped in the outmigrant traps.

Densities of chinook (fish/square meter), directly observed (low range) in the mainstem New River, varied between 0 to 0.0134 fish/m^2 (Figure 11). Densities of juvenile chinook broken down into distinct habitat types from the Salmon River, Scott River, Shasta River, and mid-Klamath River sub-basin tributaries ranged from a low of 0 to a high of 0.143 fish/m^2 with an overall average density for all unit types of 0.029

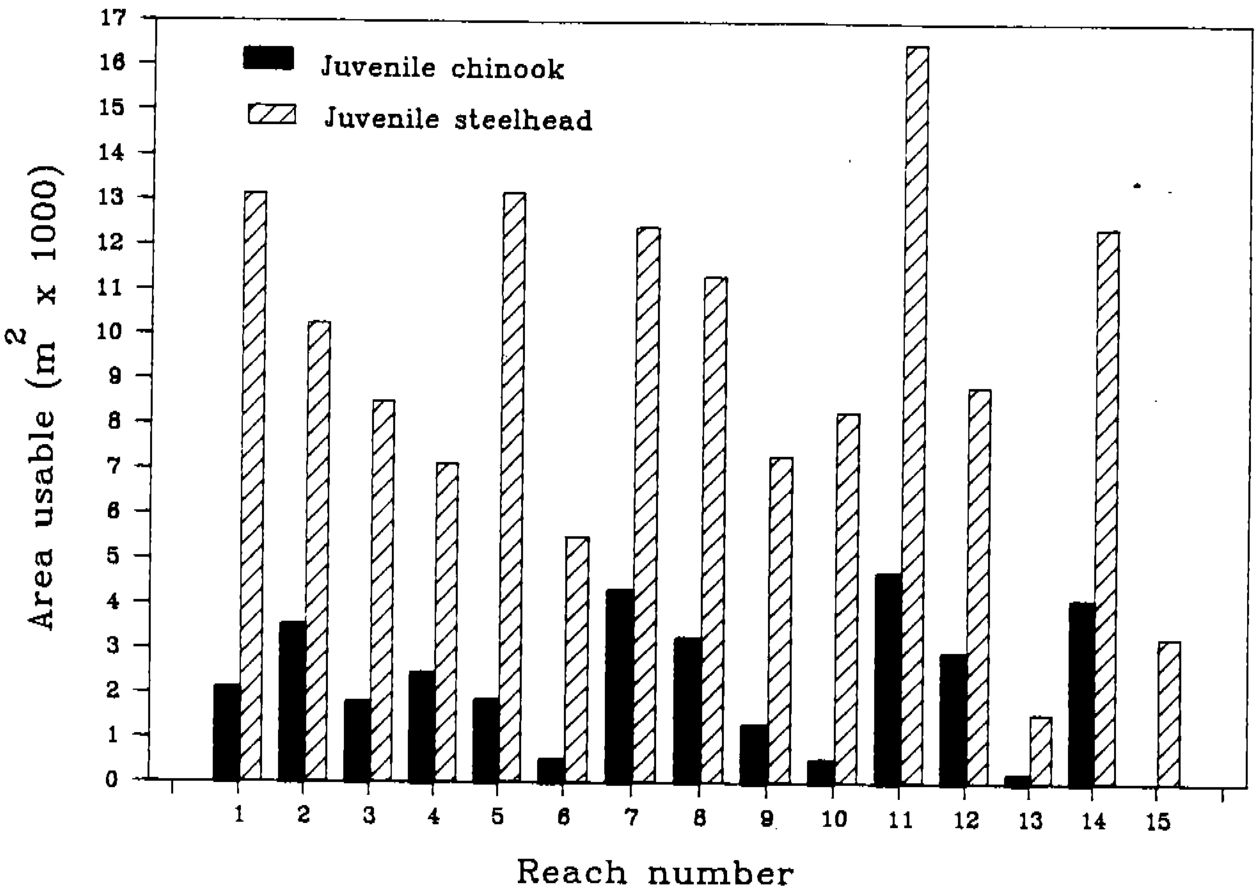


Figure 9. Rearing habitat available for juvenile chinook and steelhead (May 11 – June 12, 1989).

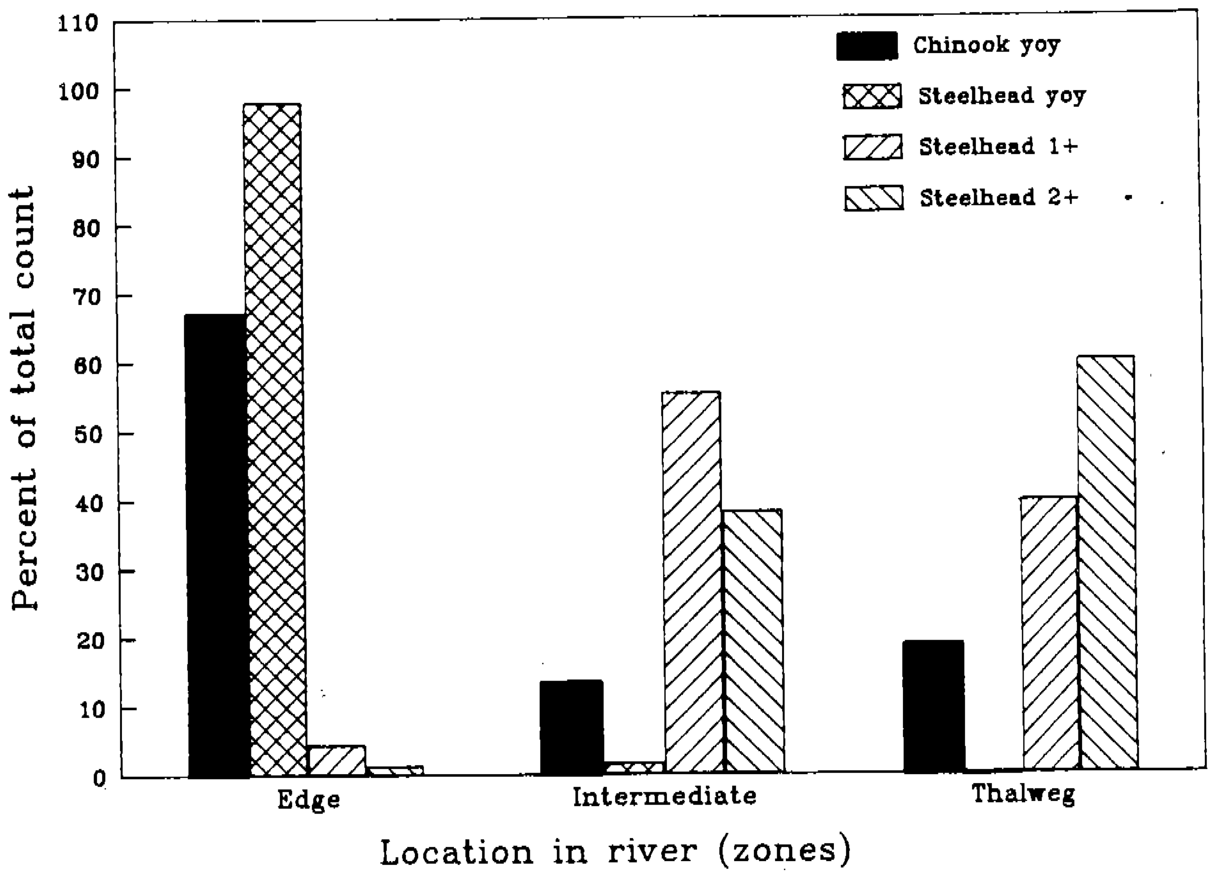


Figure 10. Location of observed juveniles (May 11 – June 12, 1989).

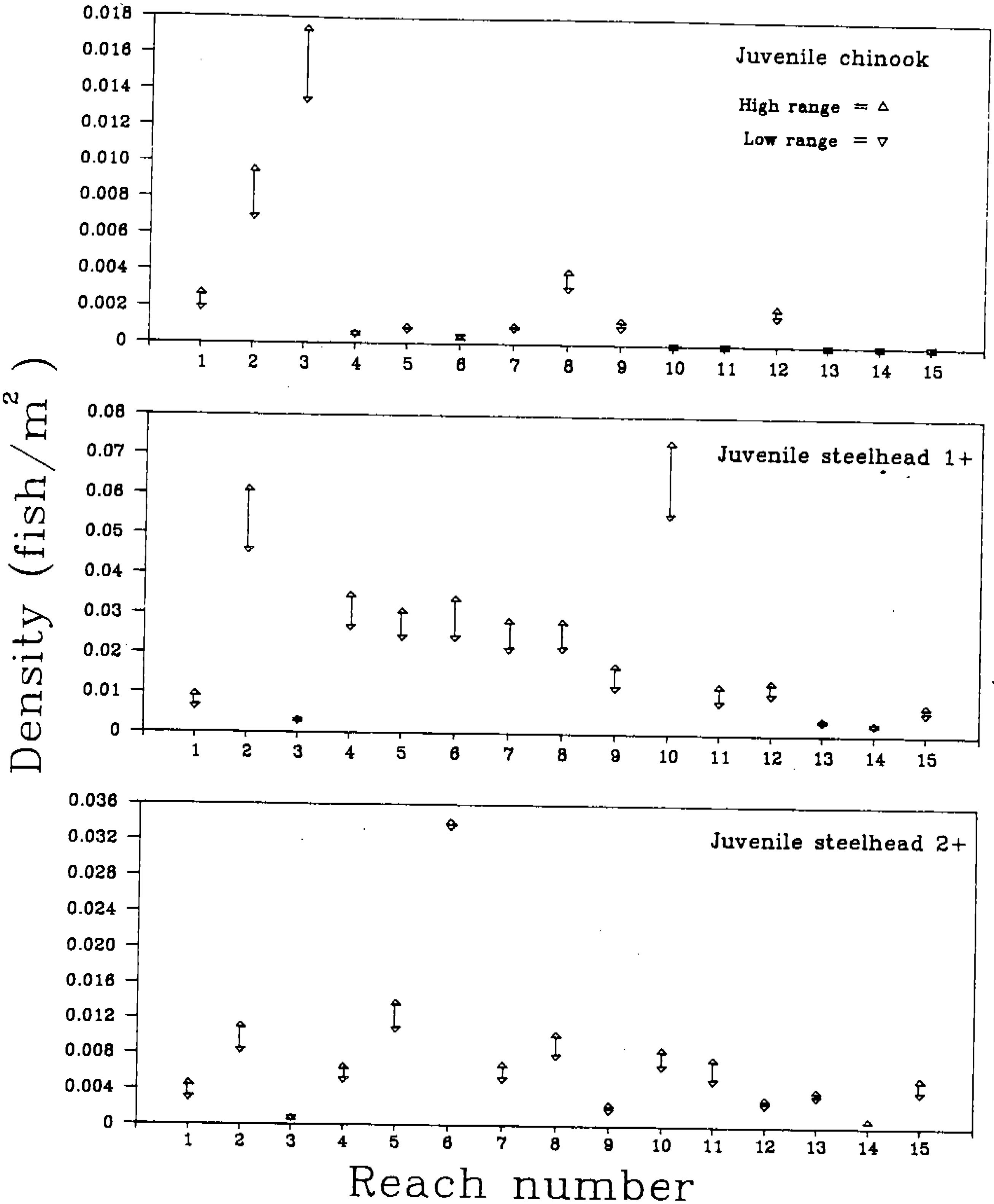


Figure 11. Observed densities of juvenile chinook and steelhead (May 11 – June 12, 1989).

$fish/m^2$ (West et al. 1989). The range of densities within each reach represents the reliability of counts. The low range indicates the numbers directly observed and the high range is indicative of percent unseen based on water transparency (bubble curtains, suspended solids, large boulders) and reliability of the diver observations. No juvenile chinook were observed between reaches 13 - 15. We assume the majority of the chinook above this area had emigrated downstream. Densities in reaches 1 - 3 were the greatest during the survey which coincides with the high numbers of outmigrants and suggests that the juvenile chinook were emigrating out of the drainage. No linear relationship was observed between available habitat and densities of chinook.

Juvenile Steelhead

New River, along with its large tributaries, is one of the better producers of summer steelhead in California and an unknown number of winter steelhead (Table 5). Adult summer steelhead are known to spawn in intermittent streams, but juveniles will emigrate into perennial streams soon after emergence (Moyle et al. 1989).

Steelhead of all sizes are most often found over large rubble substrate and rarely more than 15cm off the bottom. They shift from shallow, slow water at the stream margin to deeper, faster water as they increase in length. There is no evidence that steelhead changed preferred habitat in the presence of juvenile chinook (Everest and Chapman 1972). The rearing habitat of the mainstem of New River does not appear to be limited for steelhead 1+ and 2+. Numerous pools with large bubble curtains, low and high gradient pocket water, low gradient riffles, and numerous large boulder pools provide excellent habitat for the rearing of steelhead.

Between reach 1 and the confluence of Virgin and Slide creeks (rkm 3.1 - 37.6), rearing habitat for juvenile steelhead was estimated as 140,317 square meters at flows ranging from 200

Table 5. Summer steelhead population estimates in northern California streams from 1977-1990 (Gerstung pers. comm.).

River/System	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977
Middle Fork Eel	449[a]	726[a]	711[a]	1150	1000	1463	1524	666	1051	1600	1052	1298	377	654
Van Duzen River	4[b]	4[b]	42[b]	51[a]	nd	nd	58[a]	13[b]	8[a]	nd	25[b]	31[b]	nd	nd
Mad River	33[b]	20[b]	60[b]	19[b]	nd	52[b]	147[b]	37[b]	172[a]	8[b]	42[b]	nd	nd	nd
N.F. Trinity River	554[a]	600[d]	624[a]	nd	nd	nd	179[a]	159+[a]	116[b]	225[a]	454[a]	320[a]	nd	nd
S.F. Trinity River	66[a]	37[a]	26[a]	nd	73[a]	8[c]	nd	nd	27[a]	nd	nd	91[a]	nd	nd
New River	343[a]	687[a]	600[b]	nd	nd	nd	355[a]	nd	350[d]	236[a]	320[a]	344[a]	nd	nd
Salmon River	48[a]	82[b]	200[d]	100[d]	106[d]	97[d]	nd	nd	257[a]	108[d]	233[a]	nd	nd	nd
Wooley Creek	73[a]	234[a]	379[a]	280	nd	290	92	78	353	245	165	160	105	510
Canyon Creek	15[a]	nd	32[a]	nd	nd	10	9	3	20	4	6	nd	nd	nd
Redwood Creek	14[b]	0[b]	8[b]	17[a]	19[b]	44[b]	44[b]	5[b]	2[b]	16[b]	4[b]	nd	nd	nd
Elk Creek	29[a]	150[b]	63[a]	31[a]	nd	nd	18[a]	nd	249[a]	47[b]	90[a]	nd	408[a]	4[c]
Indian Creek	12[b]	154[b]	41[b]	nd	nd	nd	nd	nd	16[b]	nd	nd	nd	421[a]	nd
Clear Creek	91[a]	917[a]	678[a]	512[a]	428[b]	162[c]	156[b]	258	618[a]	270[a]	241[a]	79[a]	1810[a]	nd
Dillon Creek	74[a]	60[d]	294[b]	77[a]	nd	nd	200[a]	300[a]	344[a]	187[a]	268[a]	nd	nd	nd
Red Cap Creek	7[b]	23[b]	25[b]	29[b]	nd	18[b]	11[b]	12[a]	45[b]	nd	10[b]	nd	nd	nd
Bluff Creek	91[b]	44[b]	91[a]	73[a]	73[b]	23[c]	48[a]	23[a]	87[a]	16[d]	37[d]	41[b]	nd	nd
S.F. Smith River	18[b]	1[b]	12[b]	nd	nd	nd	nd	nd	5[a]	nd	nd	nd	nd	nd

[a]Population estimated from surveys of 70-100 % holding areas.
[b]Population estimated from surveys of 50-69 % holding areas.
[c]Population estimated from surveys of < 24 % holding areas.
[d]Estimated based on expansion of a partial count.
[e]Data combined form the North Fork, South Fork, and East Fork Salmon River.
nd = no data.

- 400 cfs (Figure 9). Juvenile steelhead (excluding yoy) rearing areas were abundant throughout the mainstem (Figure 11). A low availability estimate was derived for reach 13 which is classified as a A3 channel type (deeply entrenched, very confined, and very limited in cover).

Densities for steelhead 1+ (directly observed = low range) varied from 0.0028 to 0.026 fish/m^2. Densities for steelhead 2+ (directly observed = low range), ranged from 0.00065 to 0.01075 fish/m^2 (Figure 11). Densities of steelhead 1+ for distinct habitat types in the Salmon River, Scott River, Shasta River, and mid Klamath River sub-basin tributaries ranged from a low of 0.014 to a high of 1.143 fish/m^2 with an overall average density of 0.252 fish/m^2 (West et al. 1990). These estimates suggest that densities in the New River are low for the Klamath/Trinity basin. During the sample period (May 11 - June 12, 1989), large numbers of steelhead 1+ and 2+ were actively emigrating. Although steelhead yoy were not considered in density measurements due to the low reliability of counting fry, they were observed primarily in the edge zone among the cobble and small boulders in water depths as shallow as 5 cm. Locations of steelhead, based on direct observation, for yoy, 1+, and 2+ in the edge, intermediate, and thalweg zones are presented in Figure 10. Steelhead yoy were located predominantly in the edge zone while steelhead 1+ and 2+ were primarily located in the intermediate and thalweg zones. Due to the presence of numerous pools in the New River system, densities were lower than expected. Juvenile steelhead do not preferably inhabit the mid pool areas but are usually found in the heads and tails of pools where the food concentrations, velocities, and cover are the greatest. The center of the pool habitats were barren of fish; therefore, creating an overall low density for these units. High flushing flows that occur in the spring and the lack of riparian vegetation and the recruitment of woody debris due to the steep embankments contribute to the lack of cover within the dominating pool habitats.

Population Trends

Summer Steelhead Adult Counts

Summer steelhead counts were conducted during September 1989 and 1990 in the New River drainage; 687 and 343 were counted, respectively. The 1989 count was considerably higher than expanded estimates from previous years, which had not exceeded 355 (Table 5). The count for 1990 included the East Fork of New River (10 adults) which was not included in previous surveys (Table 6). The 1990 count was considerably lower than 1989 but fell within the expanded counts made in previous years. The adult summer steelhead were observed in a variety of habitat types. Even at the extremely low flows experienced in 1990, the summer steelhead were not restricted to deep pools. Adults were also observed in low and high gradient riffles, under large boulders, and in pocket water and glides (Figure 12).

Approximately 50+ miles of the New River drainage are accessible to the adults and provide excellent rearing habitat for the juveniles.

Habitat degradation, poaching, and other factors have combined to reduce the summer steelhead populations in California to critical levels (Moyle et al. 1989). Suction dredge mining is widespread throughout the mainstem New River where the majority of adults were located. The impact of dredge mining and subsequent disturbance of adults from their natural holding habitats is unknown. Poaching may be a large influence on the summer steelhead in New River. USFWS employees have observed poaching in the Virgin/Slide Creek confluence pool. It is unknown how many summer steelhead are illegally harvested from the New River drainage. During low flows (summer and fall), the adults are vulnerable due to their aggregation in pools.

Spring Chinook Salmon Adult and Redd Counts

Spring chinook adults were counted during September of 1989 and 1990 in the mainstem New River (Table 6). No juvenile or

Table 6. Adult summer steelhead and spring chinook counts in the New River watershed based on snorkel surveys conducted September 1989, and 1990, and expanded estimates from previous surveys.

	Summer Steelhead 1989	Summer Steelhead 1990	Spring Chinook 1989	Spring Chinook 1990
Mainstem New River				
Mouth to Bell Creek	108	65	23	7
Bell Creek to Quinby Creek	146	81	4	2
Quinby Creek to East Fork	177	88	4	3
East Fork to Virgin/Slide conf.	220	49	3	1
Virgin Creek Mouth to Soldier Ck.	15	12	0	0
Eagle Creek Mouth to North Fork	7	20	0	0
Slide Creek Mouth to Eagle Ck.	7	18	0	0
East Fork of New River Mouth to North Fork	[a] n.s.	10	0	0
Total	687	343	34	13
[b] 1979	344			
1980	320			
1981	236			
1984	355			

[a] n.s. = no survey

[b] Counts based on an previous surveys of 70-100% of total holding areas.

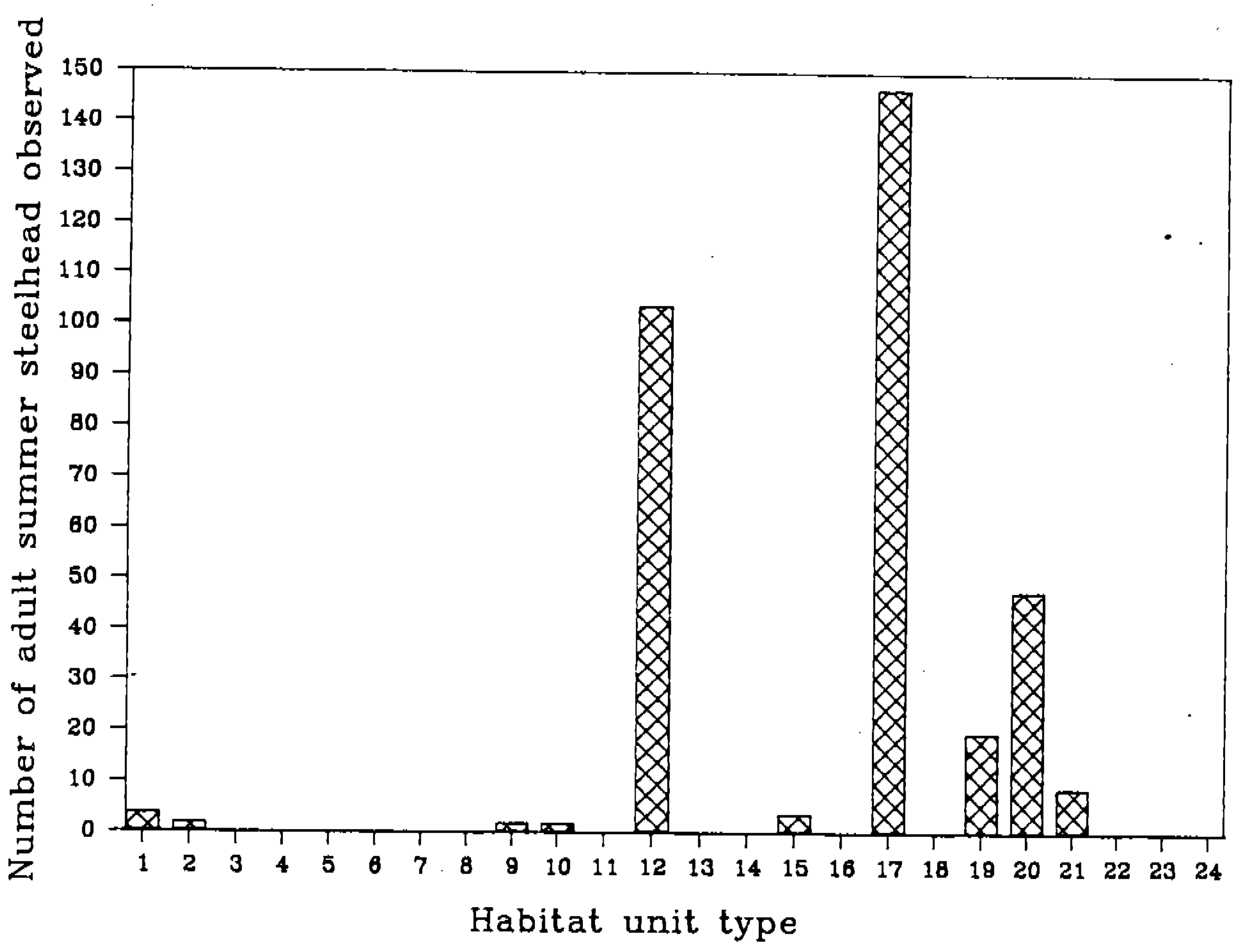


Figure 12. Habitat unit type locations of summer steelhead adults (September 1990).

adult chinook have been observed in the tributaries; therefore, all emphasis was focussed on the mainstem.

In the Trinity River, spring chinook carcasses were first collected in mid-September. Their numbers peak in early October while fall chinook carcasses were first observed in early October, their numbers peak in early to mid November (Zuspan pers. comm). Trinity Hatchery spawns spring chinook between September 1 and October 13 and fall chinook between October 9 and December 17 (Hassler pers. comm.). It is still unknown if fall chinook are using the drainage. A total of 16 redds were observed between October 12 and November 17, 1988 (Figure 13). The October discharge was only 25 - 30 cfs. Rains in early November increased the flow to over 200 cfs which coincided with an increase in the number of chinook observed. It could not be determined if the redd observed on November 10, 1988, were late run spring chinook or fall chinook. The last chinook seen in 1988 was on November 17, but no new redds were observed after November 10. A total of 34 adult chinook were seen in the mainstem in September, 1989. Seventeen of the adults were observed in the lower 0.5 kilometers of the mainstem. A total of 14 redds were counted in 1989. Chinook counts were down again in 1990. Only 13 adults were observed in September with the majority being found in the lower kilometer of the mainstem. A total of 11 redds were observed in 1990 (Figure 13).

It is unknown how many redds are necessary to maintain a viable population of spring chinook in the New River drainage. Genetically, to maintain good genetic variation in a gene pool and decrease the chance of inbreeding depression, at least 50 adults (short term) and 500 adults (long term) are suggested (Franklin 1980). Hydraulic mining activities and complete water diversions during the gold rush may have greatly impacted the population for many years. Personal communications with local residents imply that large runs were present in the 1950's. Thomas (pers. comm.) mentioned that in the mid 1950's the lower pools in New River were abundant with adult spring chinook.

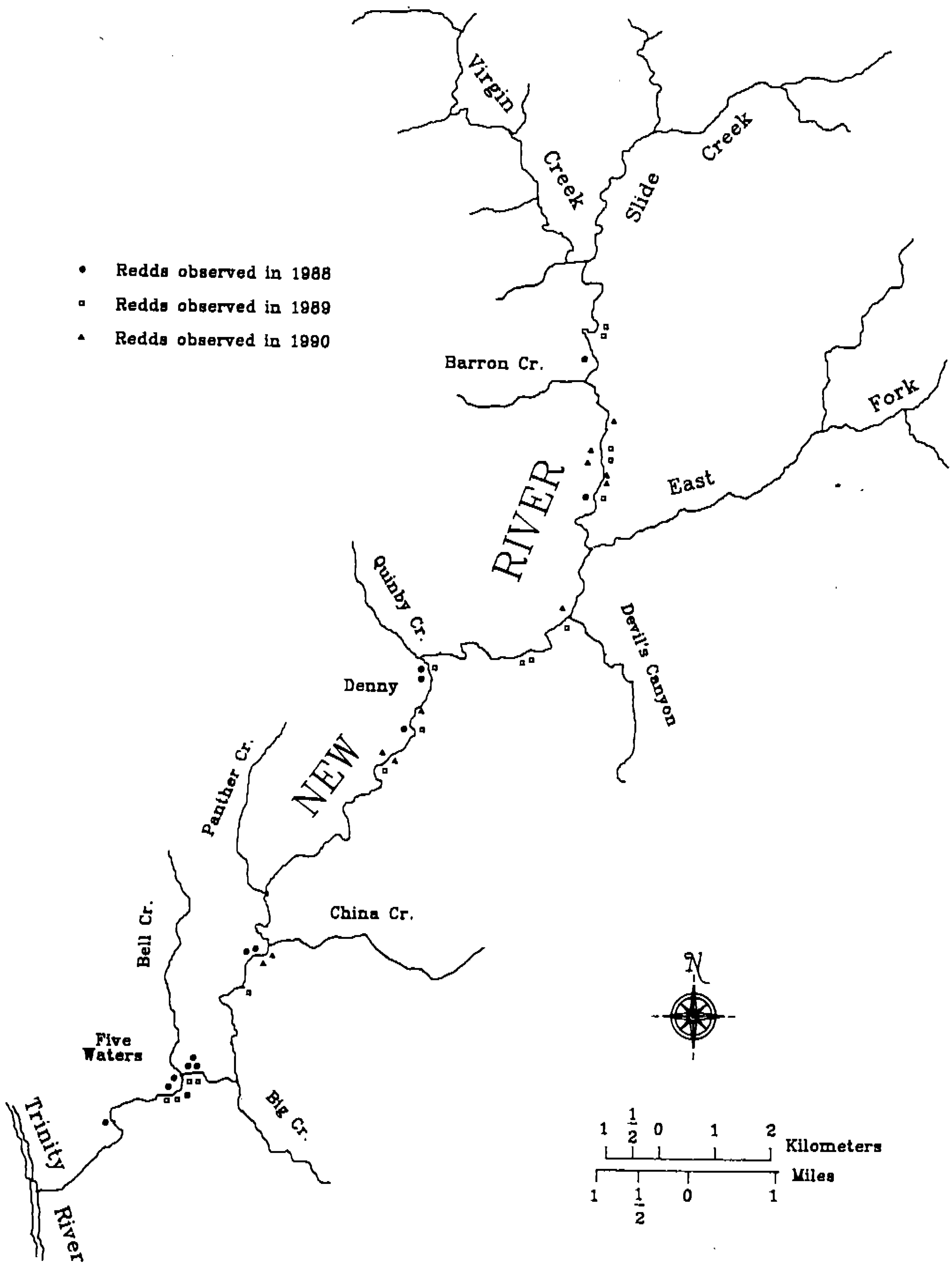


Figure 13. Locations of chinook redds observed in New River in fall 1988, 1989, and 1990.

Over harvest, the 1964 flood, and the current drought are also taking toll on this population.

Juvenile Trapping

Rotary Screw Trap 1989

Downstream migrant trapping occurred from April 7 through July 14, 1989, by use of a rotary screw trap (Figure 5). Total capture for the 1989 trapping season was 495 chinook yoy, 188 steelhead yoy, 1,099 steelhead parr, and 200 steelhead smolts (Table 7).

Table 7. Rotary screw trap summary for the 1989 and 1990 trapping seasons.

	1989				1990			
	Steelhead			Chinook	Steelhead			Chinook
Month	yoy	Parr	Smolt	yoy	yoy	Parr	Smolt	yoy
Apr.	0	67	3	4	1	4,669	1,349	25
May	2	662	173	55	31	645	231	341
Jun.	140	364	22	375	297	50	7	350
Jul.	46	6	2	61	201	29	3	106
Aug.					0	0	0	0
Sep.					28	4	0	0
Oct.					6	0	0	0
Nov.					9	0	0	0
Totals	188	1,099	325	425	573	5,397	1,590	822

Indices of total emigrating chinook, steelhead yoy, parr, and smolts are given as the expansion of numbers captured by nights fished and discharge sampled (Figures 14, 15, 16, and 17). The first juvenile chinook were trapped on April 11 (mean length = 47mm) when the trap was fishing in slow edgewater due to the high flows (1000 - 1900 cfs). The estimated emergence

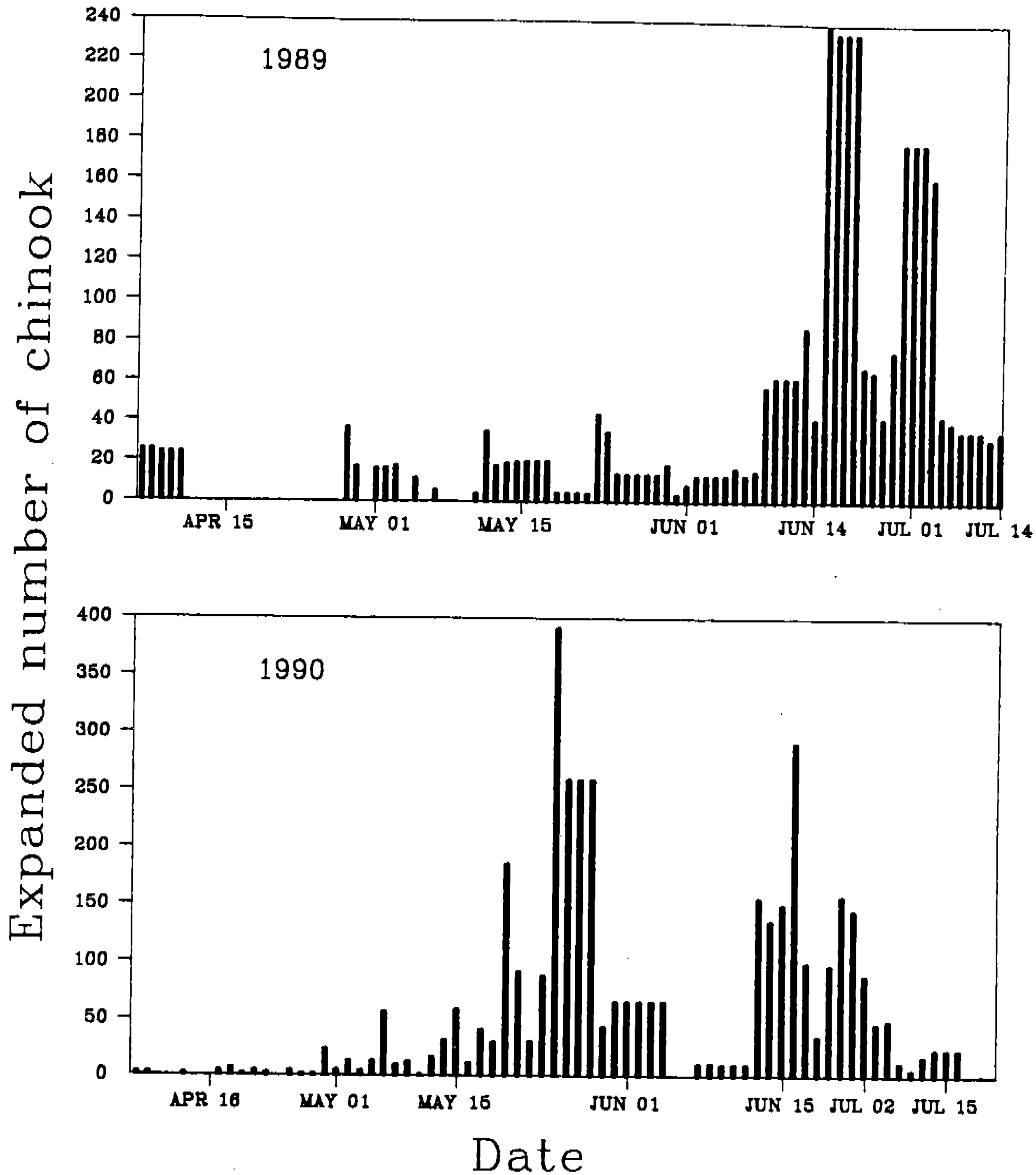


Figure 14. Rotary screw trap's expanded chinook estimate.

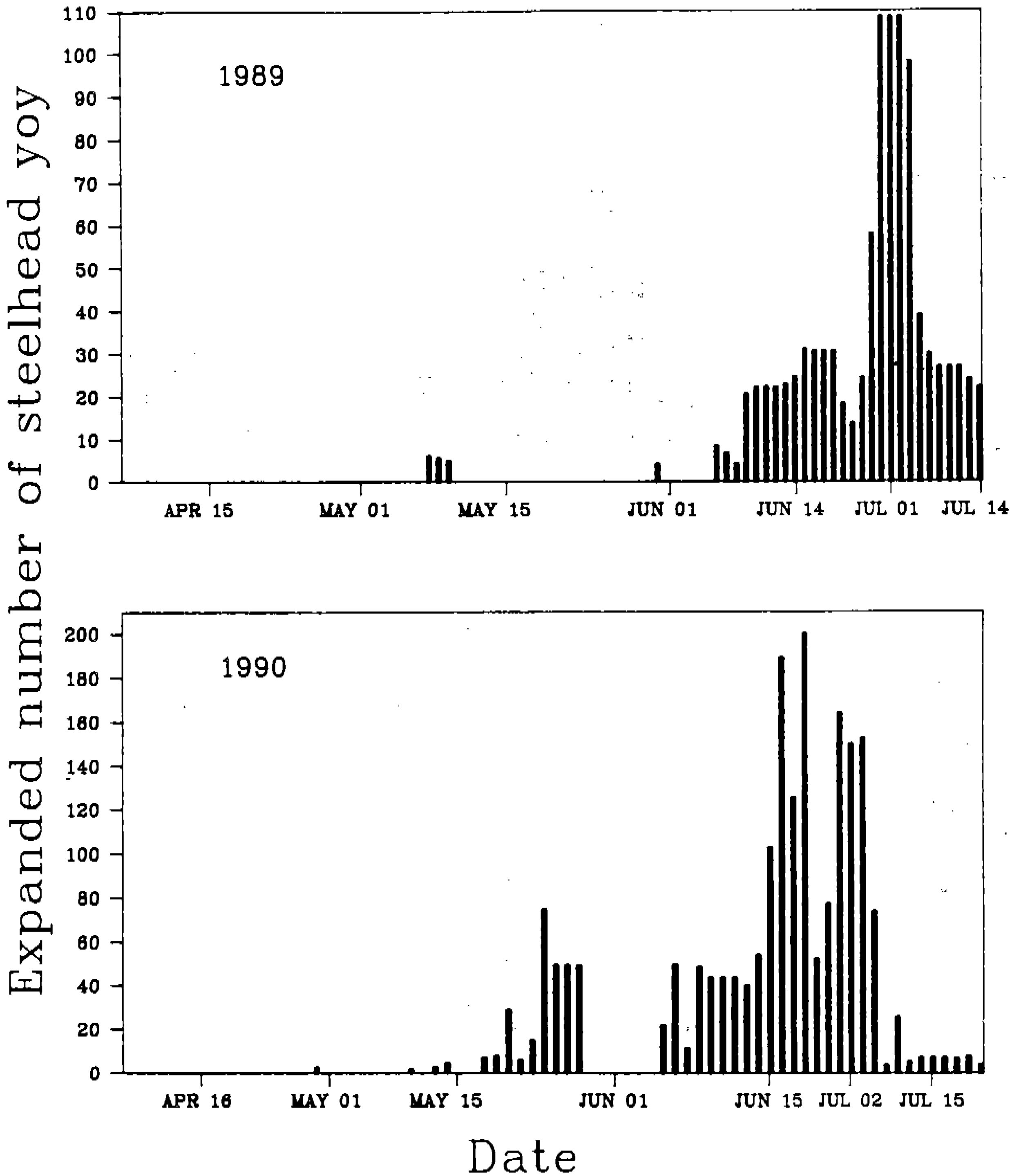


Figure 15. Rotary screw trap's expanded steelhead yoy estimate.

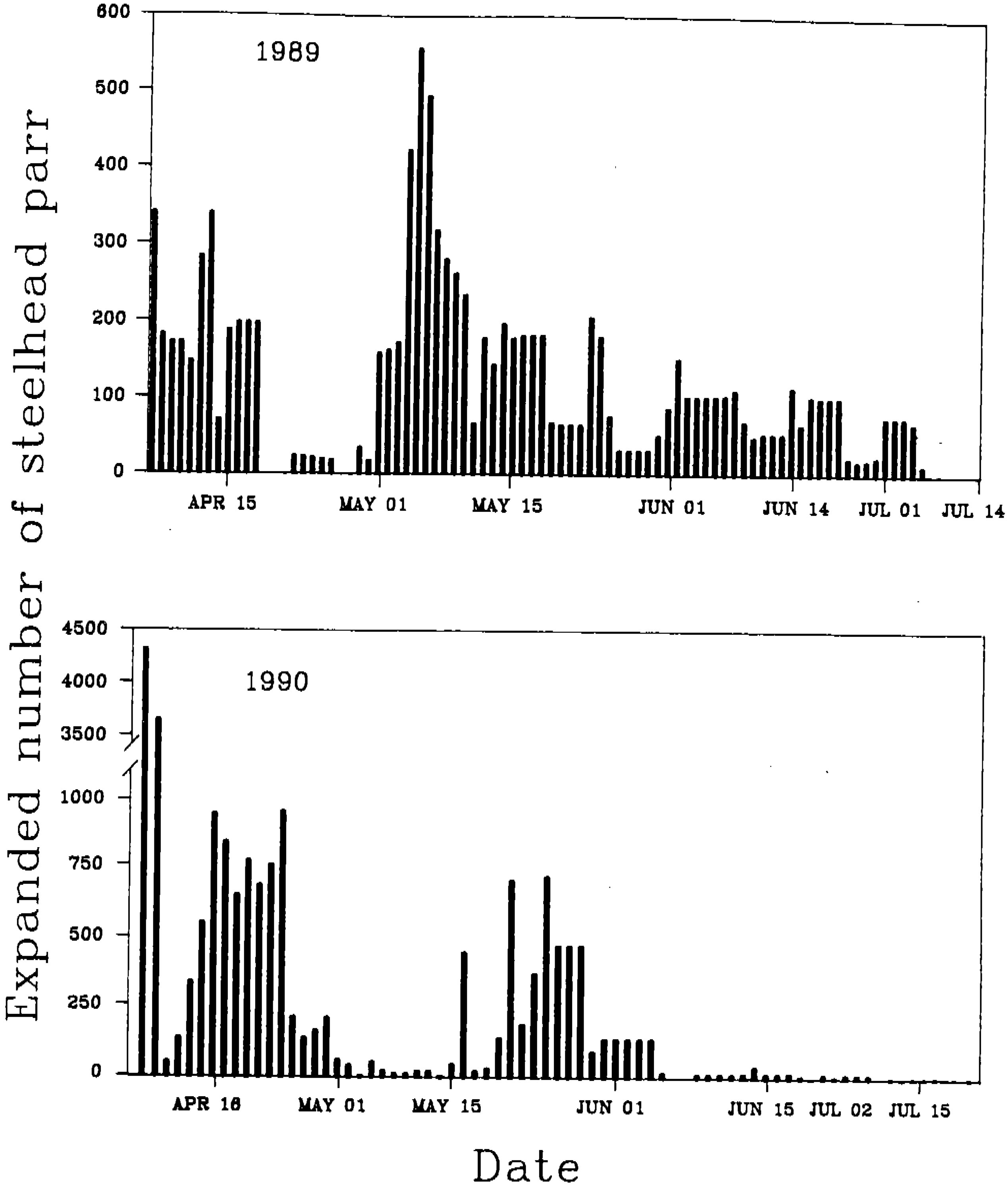


Figure 16. Rotary screw trap's expanded steelhead parr estimate.

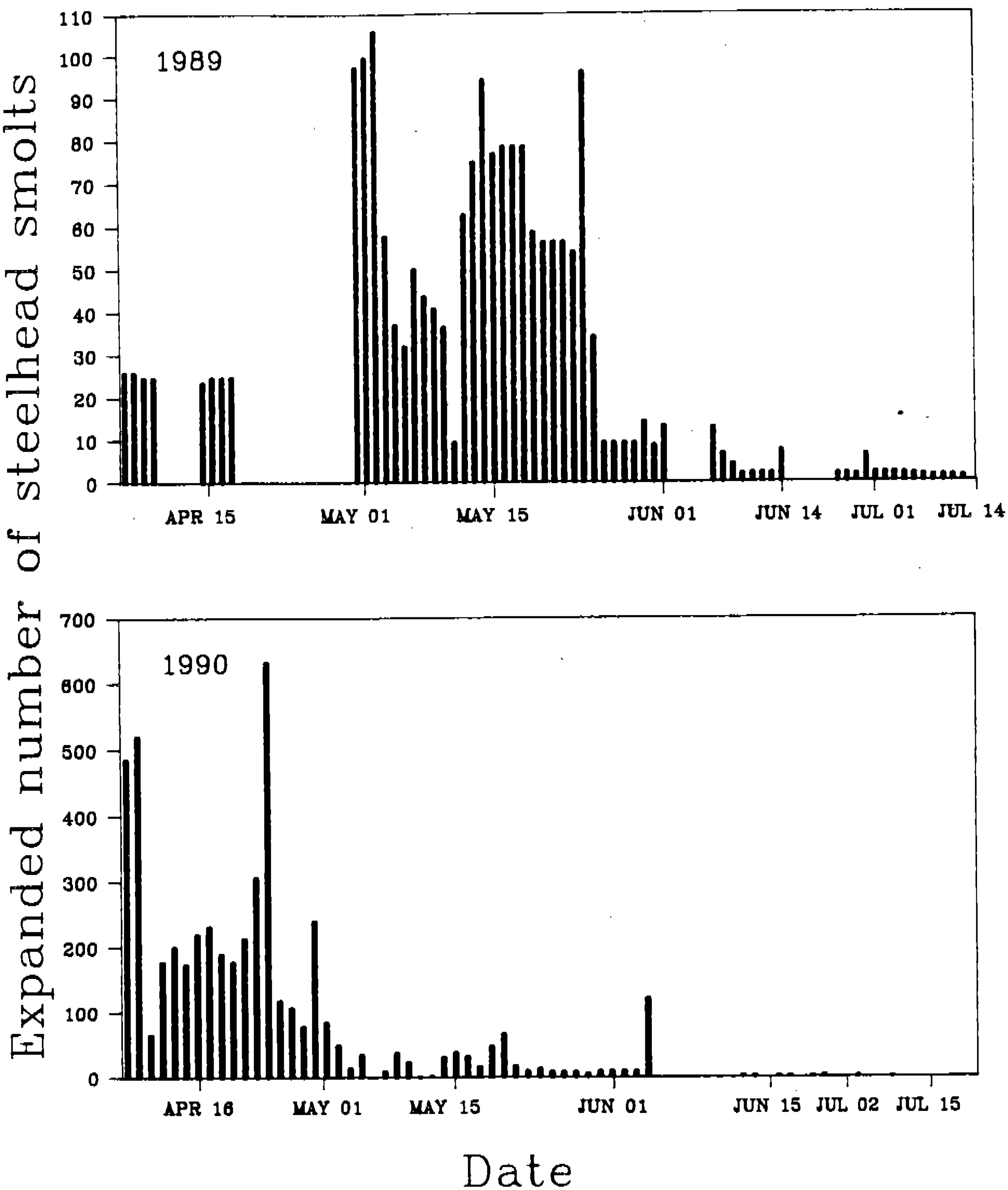


Figure 17. Rotary screw trap's expanded steelhead smolt estimate.

was around February 24, 1989, based on daily temperature units (DTU's) and assuming that the first eggs were laid on October 15, 1988, (first redd being built on October 12 and completed on October 19). When flows dropped below 500 cfs (May 1) the trap was moved into the thalweg and catches dramatically increased. Moving the trap into faster water increased the trap efficiency making earlier expansions (April 1989) not comparable. Peak emigration for juvenile steelhead (parrs and smolts) occurred during May; steelhead smolt emigration ended around the first week in June. Although the first steelhead yoy was captured in the rotary trap on May 31, a frame box trap placed at rkm 25.7 captured a steelhead yoy on May 5 (mean length = 27mm) which places time of emergence in the end of April or the first week of May. High numbers of yoy steelhead did not appear in the frame trap until April 25 and did not peak in the rotary trap until late June and early July.

Peak emigration for juvenile chinook occurred in mid June and early July. All chinook captured after June 13 were smolting.

Rotary Screw Trap 1990

Downstream migrant trapping occurred from April 5 through November 15 at rkm 3.75. The trapping season was extended in 1990 to determine if salmonids were emigrating in the fall coinciding with the lower temperatures and/or increased flow. Lack of increased flows during the fall resulted in little to no emigration. It is still unknown if the juveniles are displaced or actively emigrate during the fall and winter months. The trap will be operated in the fall of 1991 to help document potential movement coinciding with higher discharges and/or winter conditions.

Total capture for 1990 in the rotary trap was 822 chinook yoy, 573 steelhead yoy, 5,397 steelhead parr, and 1,590 steelhead smolts. Estimates of total outmigrating chinook and steelhead (yoy, parr, and smolts) were again based on the expansion for nights fished and discharge sampled. On the first night of trapping, 1 chinook yoy (length = 46mm), 1063 steelhead parr, and 127 steelhead smolts were captured. These high numbers of juvenile steelhead coincided with a very low seasonal discharge prior to the May storms. Peak emigrations were shifted forward in 1990 from those seen in 1989. The shift may coincide with the higher water temperatures and the lower discharge observed in 1990. The lower discharge allowed us to trap a greater proportion of the stream and possibly reduced the amount of rearing habitat available in the upper drainage, subsequently encouraging juveniles to emigrate.

A large proportion of the juvenile chinook were moving downstream in May with another peak in June. The majority of steelhead parr and smolts were passing through in April and May. No steelhead smolts were observed after July .

The two outmigrant peaks observed in 1989 for juvenile chinook were seen again in 1990 (Figure 14). The first peak was observed in mid May and the second in mid June. The majority of chinook (78%) captured did not show signs of smoltification. Chinook began to smolt in late June and all chinook captured after July 12 were smolts. No chinook were captured after July 18 and snorkel observations confirmed that the majority had left the New River drainage after mid July.

Biological Data

Histograms showing juvenile steelhead fork lengths depict specific size differences between yoy (0+), 1+, and 2+ fish (Figures 18 and 19). Scale analyses were preformed on the 1990 steelhead data and also showed the distinct cutoffs between age classes (Figures 20). Mean lengths ranged from 155 mm to 173 mm for steelhead 2+, 90 mm (April) to 137 mm (December) for steelhead 1+, 42 mm (May) to 92 mm (December) for steelhead yoy. It is apparent that little growth of juvenile steelhead occur during the winter months. Snorkel observations of juveniles during periods of cold water temperatures (<7 ^{o}C) showed little

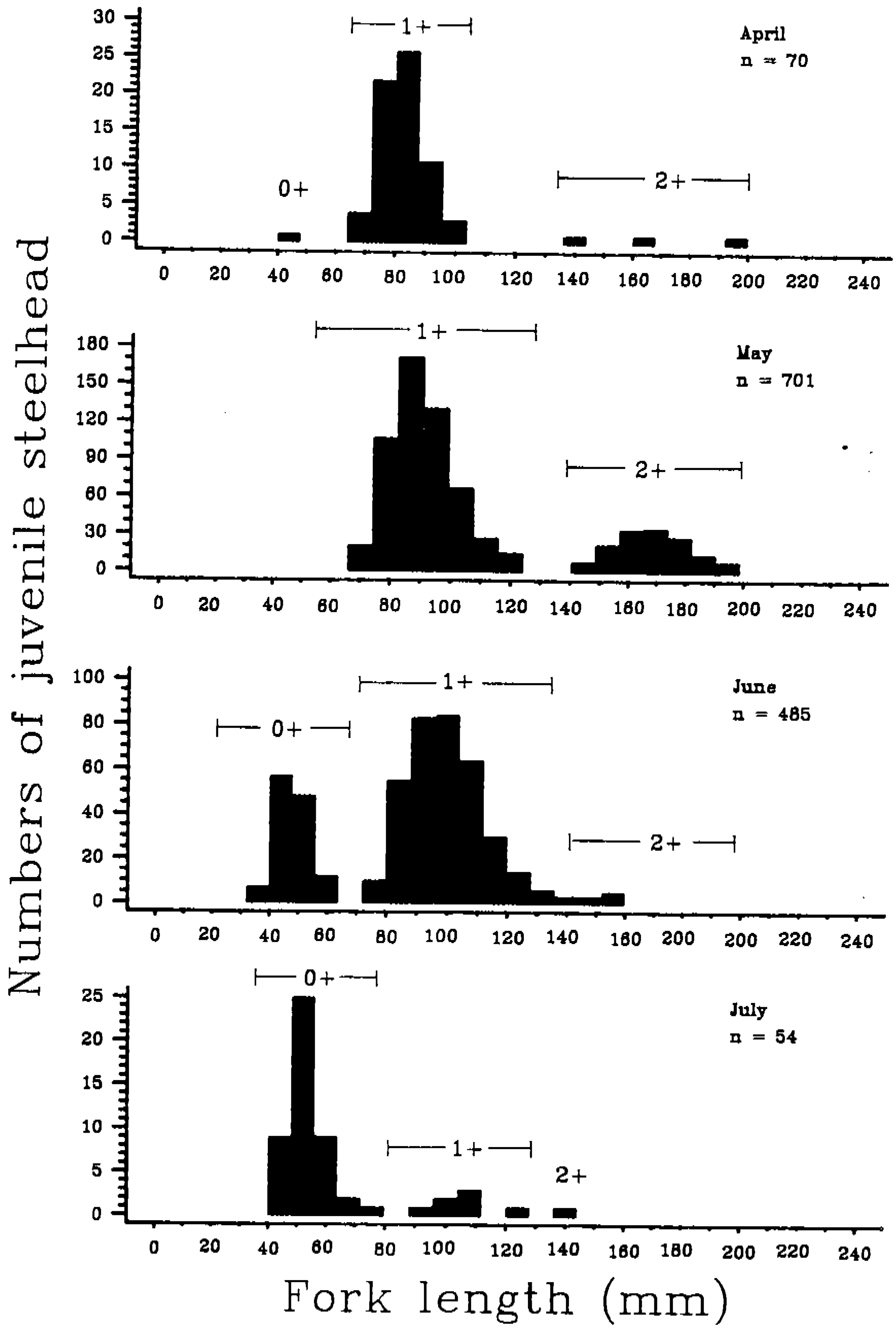


Figure 18. 1989 steelhead length frequency histograms.

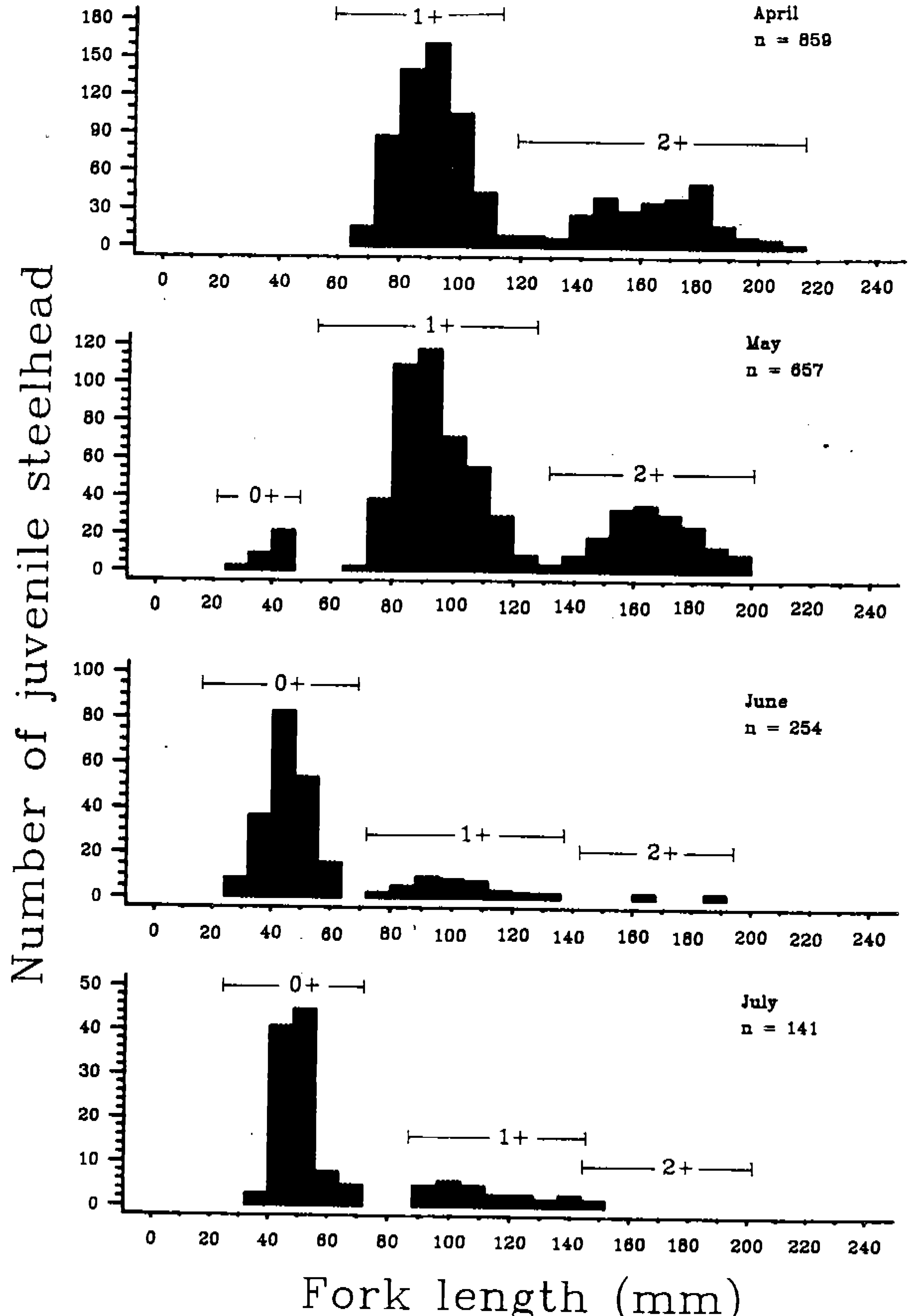


Figure 19. 1990 steelhead length frequency histograms.

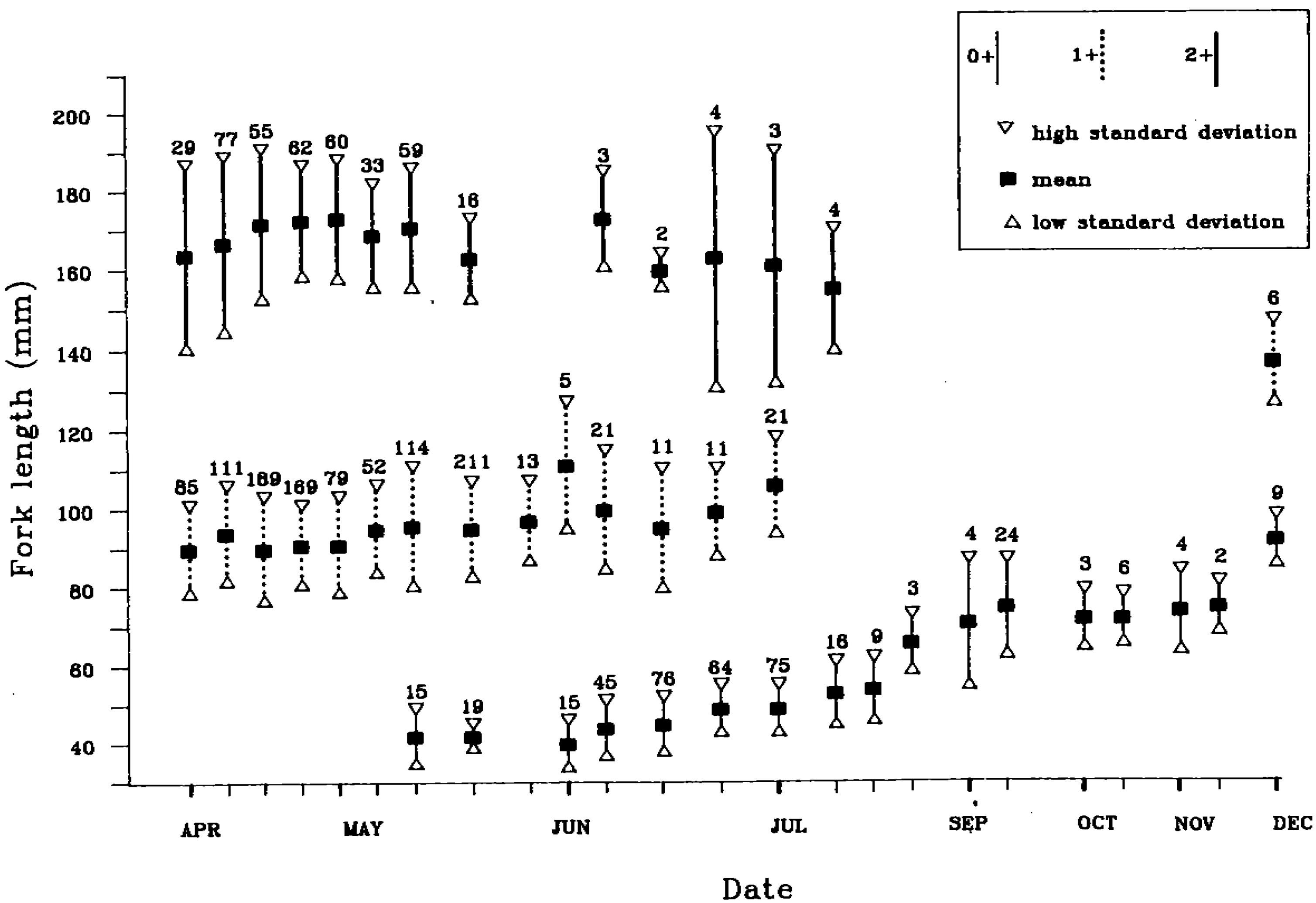


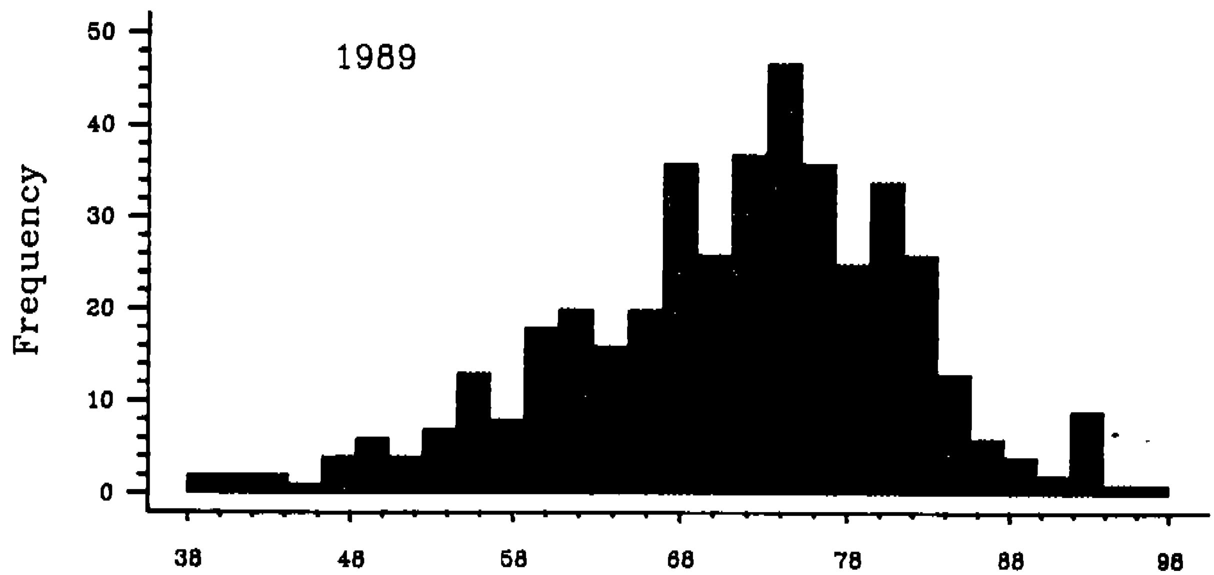
Figure 20. Steelhead age and lengths through time.

activity during daylight hours. Zedonis (pers. comm.), however, observed juvenile steelhead actively swimming and feeding during the nighttime hours. The lack of growth in juvenile steelhead observed in the New River may be attributed to the low metabolic rate in fish and the suspected lower production of aquatic insects that coincides with the cold water temperatures. Average daily temperatures in the mainstem New River ranged from 6.8°C (November 1, 1989) to 7.1°C (March 1, 1990) with temperatures as low a 2 °C occurring in late December (Figure 1).

Histograms showing juvenile chinook fork lengths for 1989 and 1990 display the sizes passing through the trap location (Figure 21). The mean fork length for the 1989 juveniles was 71.7 mm ($n = 424$, standard deviation (SD) = 10.3) while the mean fork length for the 1990 juveniles was only 65.5 mm ($n = 708$, SD = 9.4) which differed significantly ($P < 0.01$). The reasons for the growth differences of chinook between years is not known. It may be due to environmental influences on habitat and fish development and/or natural variation. Mean fork lengths for chinook in 1989 and 1990 ranged from a low in April of 38.7 and 51.5, respectively, to a high of 85.7 and 80.3 in July, respectively (Figure 22).

Length displacement relationships were determined for juvenile chinook and steelhead (Figures 23 and 24). A comparison test on the slopes of log transformed linear regressions for 1989 and 1990 data showed no significant differences ($P < .05$) for either species.

The overall condition of the juvenile salmonids were rated as excellent. No external diseases were observed, although puncture wounds from birds were observed on numerous yoy steelhead and chinook.



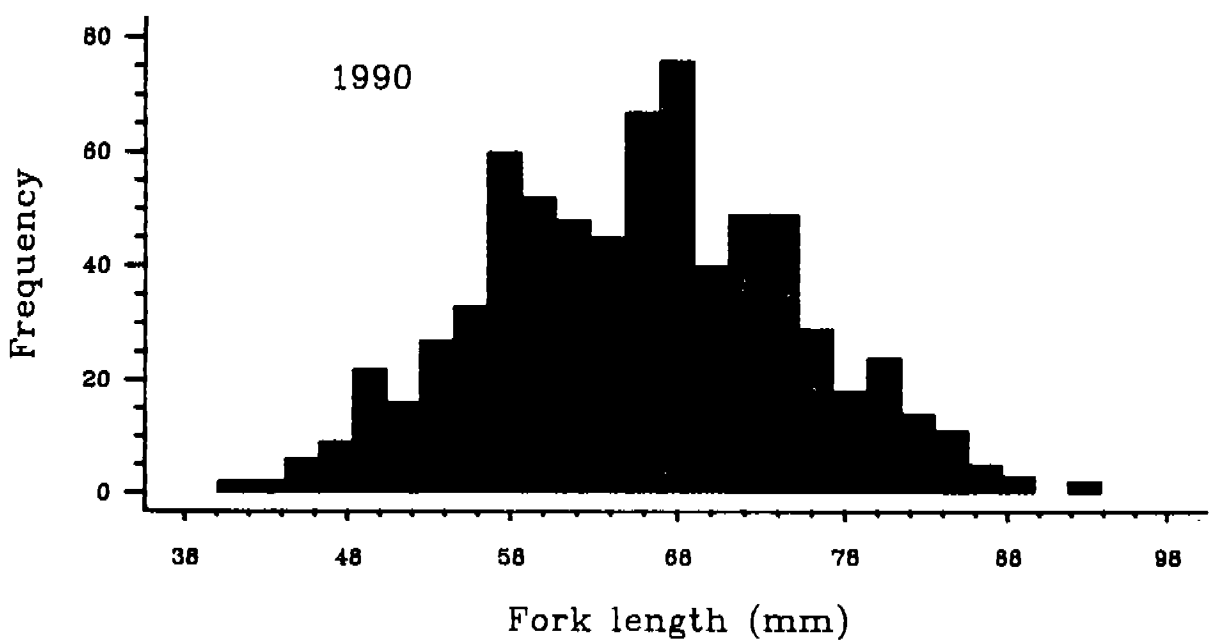


Figure 21. 1989 and 1990 juvenile chinook length frequency histograms.

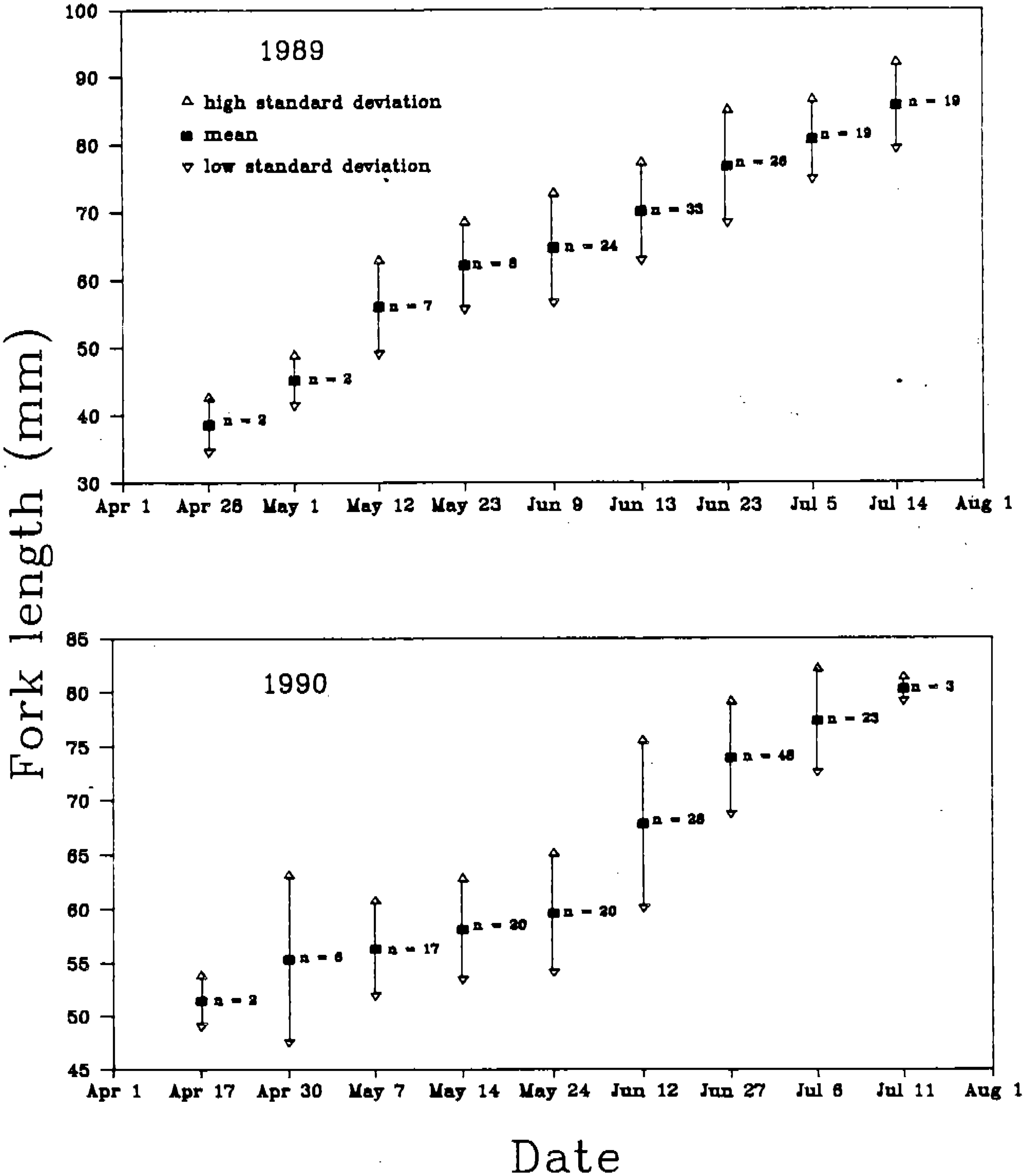


Figure 22. Juvenile chinook lengths through time.

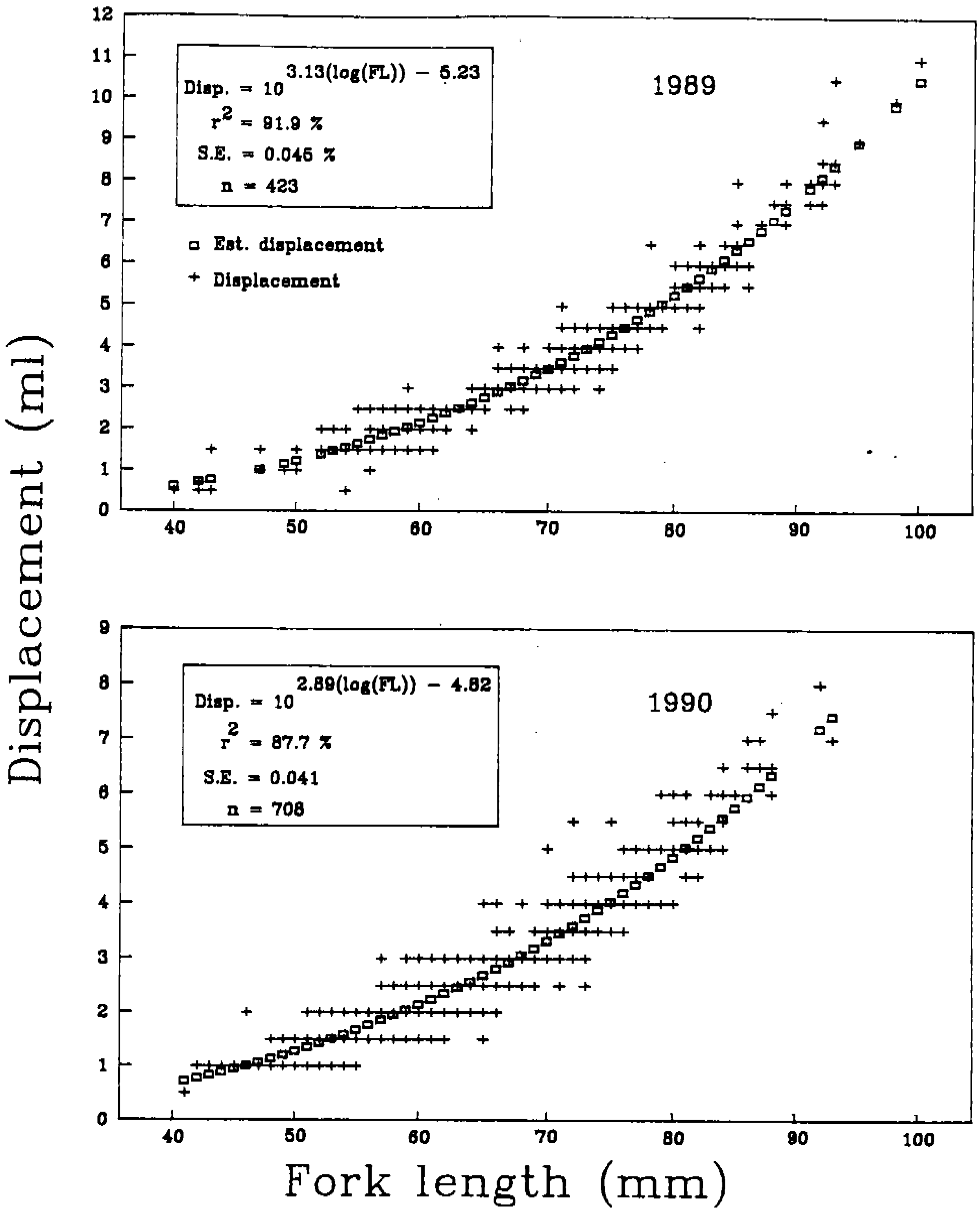


Figure 23. 1989 and 1990 juvenile chinook length displacement relationships.

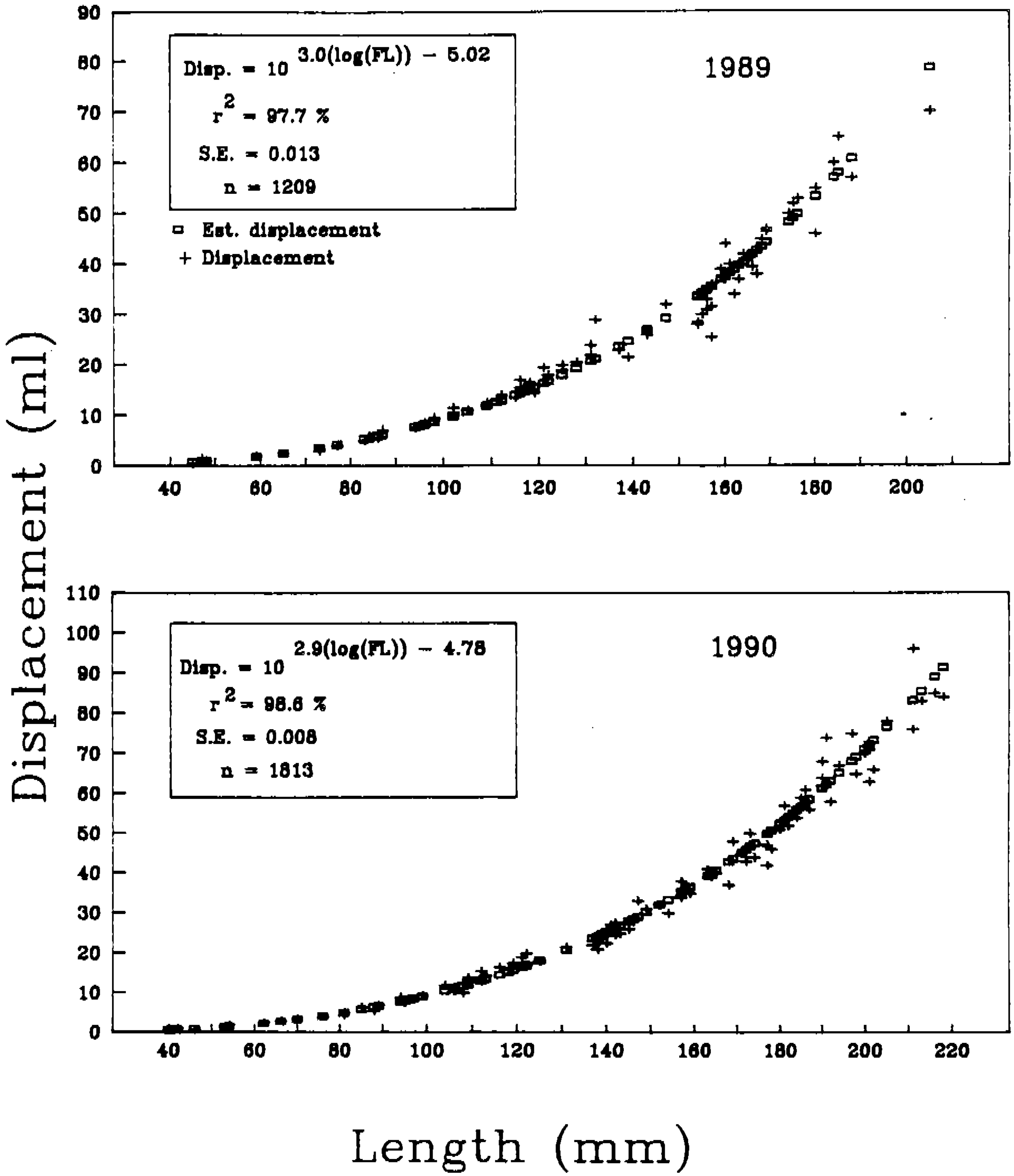


Figure 24. 1989 and 1990 juvenile steelhead length displacement relationships.

SUMMARY

The New River drainage not only has one of California's largest summer steelhead populations but also has the potential of supporting larger spring and fall chinook runs. Steelhead adult and juvenile habitat is not a limiting factor in the drainage. Eighty plus kilometers of quality steelhead spawning and rearing habitat is available, although the actual numbers of summer and winter steelhead using the drainage is uncertain. Summer steelhead adult counts in the drainage have exceeded 600 fish but average around 350. The number of winter steelhead adults will be estimated when the proposed resistance board weir is constructed and operated in 1991. Estimates of potentially available chinook spawning habitat in the mainstem suggested that the mainstem could accommodate between 1442 and 2351 spawning chinook pairs, although the effects of maximizing chinook production on the survival of steelhead is unknown. Only 11 to 16 spawning pairs of chinook are using the mainstem at this time. The attempt to introduce coho salmon to the New River drainage was unsuccessful. A total of 72,000 coho fingerlings were released in 1979, but no juveniles or adults have been observed in the drainage.

A potential for the artificial propagation of spring and fall chinook and summer and winter steelhead does exist. The collection of the "native" spring chinook brood stock would be difficult and risky due to the low numbers of adults returning to the drainage. Introduction of fall chinook into the basin is not advised at this time as they may not be native to this watershed. The summer steelhead population appears to be fluctuating at this time and could potentially rebuild itself. The USFS removal of squatters from the upper drainage which decreased the potential poaching pressures on summer steelhead may act as a protective measure to the returning steelhead populations.

New River water temperatures are in the higher range of salmon tolerances and may increase if the drought continues. Mean daily temperatures extremes of 23.3 °C (73.9 °F) were recorded in August 1990. The affect of the high water temperatures on the migrating adult spring chinook and summer steelhead in this basin is uncertain, although refuge is available in the numerous deep water pools and cool water tributaries that are located throughout the drainage.

Discharge has been monitored throughout the investigation and was estimated to range from a low of 24 cfs in August to a high of 10,000 cfs during a winter storm event. The flow was observed to rise 2 meters overnight.

Channel and habitat typing classified New River as predominantly a "B" channel configuration. A2 channel type was observed in the lower 3 kilometers, which could inhibit the upstream migration by salmonid adults during low water years. LGR, LsBk, MCP, LsBo, and POW were the predominant habitat types in the mainstem.

Rearing habitat availability is not limited for yoy chinook at present population levels. Although only a total of 34,167 square meters of usable area was estimated for chinook in the mainstem, this may not be a matter of great concern since the majority of chinook juveniles emigrate out of the drainage four months after emergence. The amount of rearing habitat available in the mainstem for steelhead was estimated as 140,317 square meters and does not appear to be limiting at present population levels.

Downstream migrant trapping has placed the peak emigration period for chinook to be in July while the peak for juvenile steelhead is late May, early April. Emergence for chinook was estimated to occur in late February while steelhead emergence occurred in April.

Activities planned for the 1991 and 1992 are to continue the downstream trapping of juvenile salmonids, monitoring of the permanent index reaches, conduct redd and adult counts, and construct and operate the resistance board weir.

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APPENDIX A

Channel classifications as described by Rosgen 1985.

Appendix A. Channel classification as described by Rosgen 1985.

Stream Type	Gradient %	Dominant Particle Size of Channel Materials	Channel Entrenchment and Valley Confinement
A1	4-10	Bedrock	Very deep; very well confined
A1-a	10 +	Same as A1	
A2	4-10	Large & small boulders w/mixed cobbles.	Same as A1
A2-a	10 +	Same as A2	
A3	4-10	Small boulders, cobble, coarse gravel. Some sands.	Same as A1
A3-a	10 +	Same as A2	
A4	4-10	Predominantly gravel, sand, and some silts	Same as A1
A4-a	10 +	Same as A4	
A5	4-10	Silt and/or clay bed and bank materials.	Same as A1
A5-a	10 +	Same as A5	

Stream Type	Gradient %	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
B1-1	1.5-4.0	Bedrock bed; banks are cobble, gravel, some sand.	Shallow entrenchment; moderate confinement.
B1	2.5-4.0 ($\bar{X}$ = 3.5)	Predominately small boulders and very large cobble.	Moderate entrenchment; moderate confinement
B2	1.5-2.5 ($\bar{X}$ = 2.0)	Large cobble mixed w/small boulders and course gravel.	Moderate entrenchment; moderate confinement.
B3	1.5-4.0 ($\bar{X}$ = 2.5)	Cobble bed w/mixture of gravel and sand. Some small boulders.	Moderate entrenchment; well confined
B4	1.5-4.0 ($\bar{X}$ = 2.0)	Very coarse gravel w/cobbles, sand and finer material.	Deeply entrenched; well confined.
B5	1.5-4.0 ($\bar{X}$ = 2.5)	Silt clay	Deeply entrenched; well confined.
B6	1.5-4.0	Gravel w/few cobbles and w/noncohesive sand and finer soil.	Deeply entrenched; slightly confined.

Stream Type	Gradient %	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
C1-1	1.5 or less ($\bar{X}$ = 1.0)	Bedrock bed, gravel, sand or finer banks.	Shallow entrenchment; partially confined.
C1	1.0-1.5 ($\bar{X}$ = 1.3)	Cobble, coarse gravel bed, gravel, sand banks.	Moderate entrenchment; well confined.
C2	0.3-1.0 ($\bar{X}$ = 0.6)	Large cobble bed w/mixture of small boulders and coarse gravel.	Moderate entrenchment; well confined.
C3	0.5-1.0 ($\bar{X}$ = 0.3)	Gravelbed w/mixture of small cobble and sand.	Moderate entrenchment; slightly confined.
C4	0.1-0.5 ($\bar{X}$ = 0.3)	Sandbed w/mixture of gravel and silt. No bed armor.	Moderate entrenchment; slightly confined.
C5	1.0 or less ($\bar{X}$ = 0.5)	Silt clay w/mixture of medium to fine sand no bed armor.	Moderate entrenchment; slightly confined.
C6	1.5 or less	Sandbed w/mixture of silt and some gravel.	Deeply entrenched; unconfined.

Stream Type	Gradient %	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
D1	1.0 or greater ($\bar{X}$ = 2.5)	Cobble bed w/mixture of coarse gravel and sand and small boulders.	Slightly entrenched; no confinement.
D2	1.0 or less ($\bar{X}$ = 1.0)	Sandbed w/mixture of small to medium gravel and silt.	Slightly entrenched; no confinement.
F1	1.0 or less	Bedrock bed w/few boulders, cobble and gravel.	Total confinement.
F2	1.0 or less	Boulder w/small amounts of cobble, gravel and sand.	Same as F1
F3	1.0 or less	Cobble/gravel bed with locations of sand in depositional sites.	Same as F1
F4	1.0 or less	Sand bed with smaller amounts of silt and gravel.	Same as F1
F5	1.0 or less	Silt/clay bed and banks with smaller amounts of sand.	Same as F1

APPENDIX B

Habitat types as described by McCain et al. 1990.

Appendix B. Habitat types and descriptions.

HABITAT TYPE		DESCRIPTION
0	Dry Channel (DRY)	
1	Low Gradient Riffle (LGR)	Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient <4%, substrate is usually cobble dominated.
2	High Gradient Riffle (HGR)	Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is >4%, and substrate is boulder dominated.
3	Cascade (CAS)	The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.
4	Secondary Channel Pool (SCP)	Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates.
5	Backwater Pool (BwBo) Boulder Formed	Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine grain substrates. Current velocities are quite low.
6	Backwater Pool (BwRw) Root Wad Formed	
7	Backwater Pool (BwL) Log Formed	
8	Trench/Chute (TRC)	Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls.

		Current velocities are swift and the direction of flow is uniform. May be pool-like.
9	Plunge Pool (PLP)	Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.
10	Lateral Scour Pool (LsL) Log Formed	Formed by flow impinging against one streambank or against a partial channel obstruction. The associated scour is generally confined to <60% of wetted channel width. Channel obstructions include rootwads, woody debris, boulders and bedrock.
11	Lateral Scour Pool (LsRw) Root Wad Formed	
12	Lateral Scour Pool (LsBk) Bedrock Formed	
13	Dammed Pool (DPL)	Water impounded from a complete or nearly complete channel blockage (debris jams, rock landslides or beaver dams). Substrates tend toward smaller gravels and sand.
14	Glides (GLD)	A wide uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel and sand.
15	Run (RUN)	Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders.

Appendix B. Continued

16	Step Run (SRN)	A sequence of runs seperated by short riffle steps. Substrates are usually cobble and boulder dominated.
17	Mid-Channel Pool (MCP)	Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.
18	Edgewater (EGW)	Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrates vary from cobbles to boulders.
19	Channel Confluence Pool (CCP)	Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.
20	Lateral Scour Pool (LsBo) Boulder Formed	Formed by flow impimging against boulders that create a partial channel obstruction. The associated scour is confined to <60% of wetted channel width.
21	Pocket Water (POW)	A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.
22	Corner Pool (CRP)	Lateral Scour Pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.

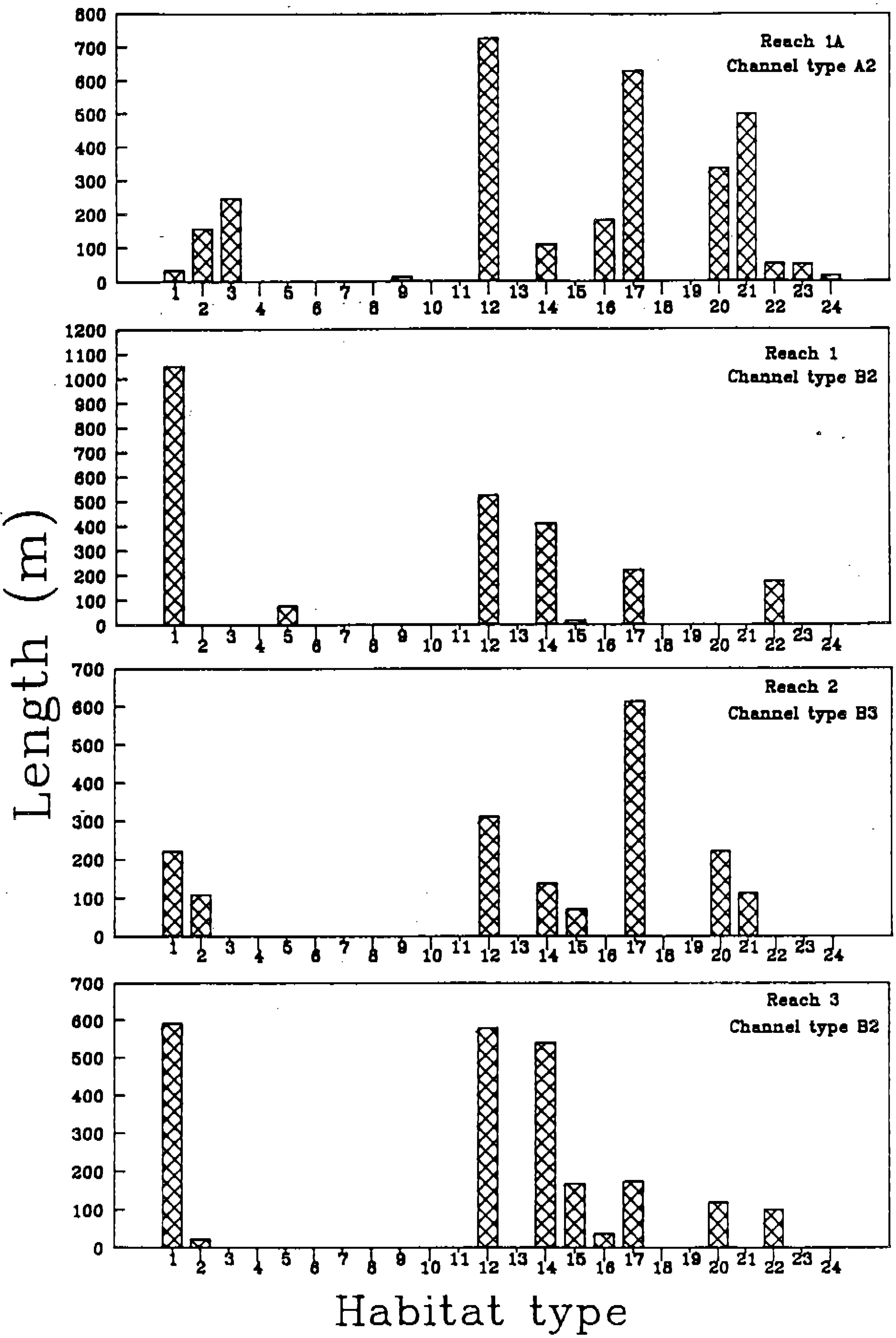
Appendix B. continued.

23	Step Pool (STP)	A series of pools seperated by short riffles or cascades. Generally found in high gradient, confined mountain streams dominated by boulder substrate.
24	Bedrock Sheet (BRS)	A thin sheet of water flowing over a smooth bedrock surface.

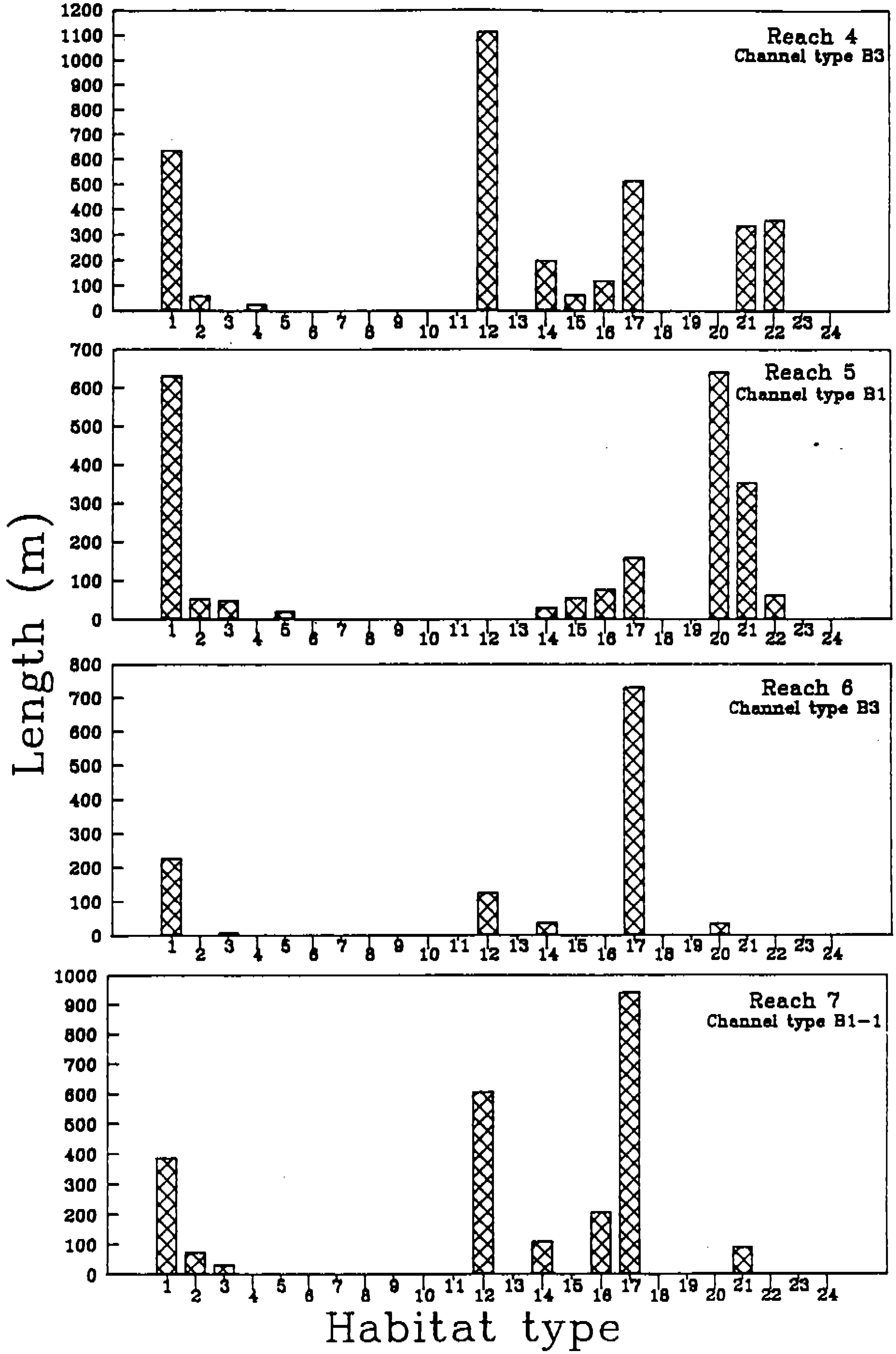
APPENDIX C

Habitat types and lengths for reach, channel type breaks.

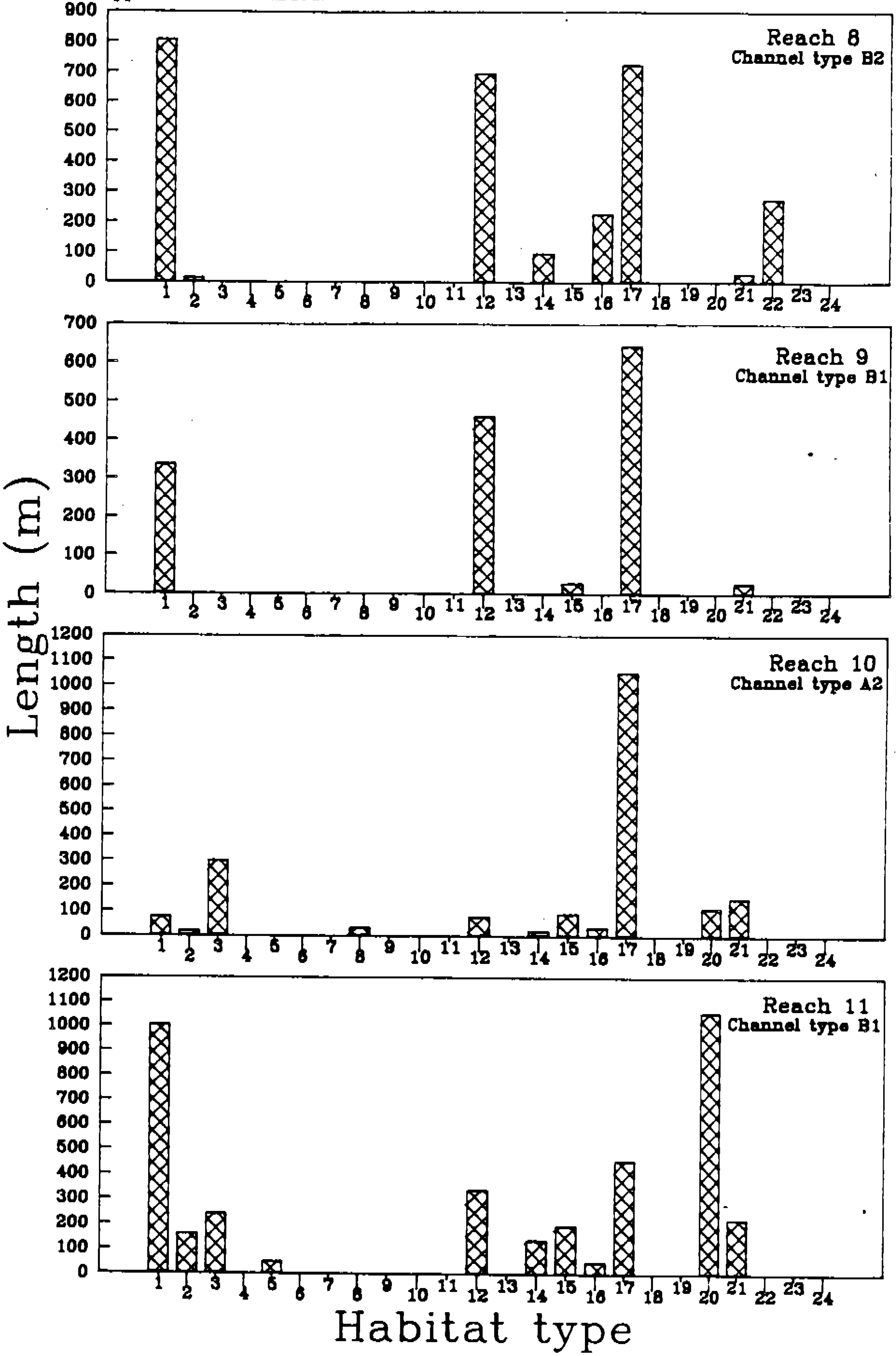
Appendix C. Habitat type and lengths for reach, channel type breaks.



Appendix C. continued.



Appendix C. continued.



Appendix C. continued.